ApexPro™ Antenna System

Site Survey and Installation

2001989-024 Revision B

GE Medical Systems
Information Technologies

gemedicalsystems.com

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Contents

For your notes

1 Introduction

For your notes

Manual Information

Revision History

Each page of the document has the document part number and revision letter at the bottom of the page. The revision letter changes whenever the document is updated.

Revision	Date	Comment
A	3 November 2000	Initial release
B	10 May 2001	Updated for international release.

Purpose of Manual

This manual is intended for service representatives and technical personnel involved with installing and maintaining an antenna system for GE Medical Systems *Information Technologies* telemetry systems. The purpose of this manual is to aid in the design, layout, testing, and troubleshooting of a telemetry antenna system. It is also intended as a guide to be used with service technical support for solving common telemetry antenna problems.

Intended Audience

This manual is intended for use by trained service representatives and biomedical engineers with a background in electronics, including analog and digital circuitry with RF and microprocessor architectures.

Safety Information

Responsibility of the Manufacturer

GE Medical Systems *Information Technologies* is responsible for the effects of safety, reliability, and performance only if:

- Assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by GE Medical Systems *Information Technologies*;
- The electrical installation of the relevant room complies with the requirements of the appropriate regulations; and
- The device is used in accordance with the instructions for use.

Intended Use

This device is intended for use under the direct supervision of a licensed health care practitioner.

This device is not intended for home use.

Federal law restricts these devices to be sold by or on the order of a physician.

Contact GE Medical Systems *Information Technologies* for information before connecting any devices to the equipment that are not recommended in this manual.

Parts and accessories used must meet the requirements of the applicable IEC 60601 series safety standards, and/or the system configuration must meet the requirements of the IEC 60601 medical electrical systems standard.

Periodically, and whenever the integrity of the device is in doubt, test all functions.

The use of ACCESSORY equipment not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system. Consideration relating to the choice shall include:

- use of the accessory in the PATIENT VICINITY; and
- evidence that the safety certification of the ACCESSORY has been performed in accordance to the appropriate IEC 60601 and/or IEC 60601 harmonized national standard.

If the installation of the equipment, in the USA, uses 240V rather than 120V, the source must be a center-tapped, 240V, single-phase circuit.

Definitions of Warnings, Cautions, and Notes

Danger, Warnings, Cautions, and **Notes** are used throughout this manual to designate a degree or level of hazardous situations. Hazard is defined as a source of potential injury to a person.

DANGER
indicates a potential hazard or unsafe practice which, if not avoided, could result in death or serious injury.

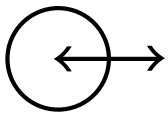
WARNING
indicates a potential hazard or unsafe practice which, if not avoided, could result in minor personal injury or product/property damage.

CAUTION
provides application tips or other useful information to assure that you get the most from your equipment.

NOTE: provides application tips or other useful information to assure that you get the most from your equipment.

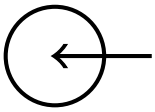
Equipment Symbols

The following symbols appear on the equipment.

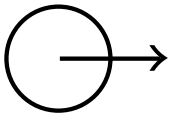


DC In/RF Out or DC Out/RF In

Attention: Consult accompanying documents before using the equipment.



DC In or RF In



RF Out or DC Out

For indoor use only.

Power supply cable configuration.

+ = Power

– = Return

Service Information

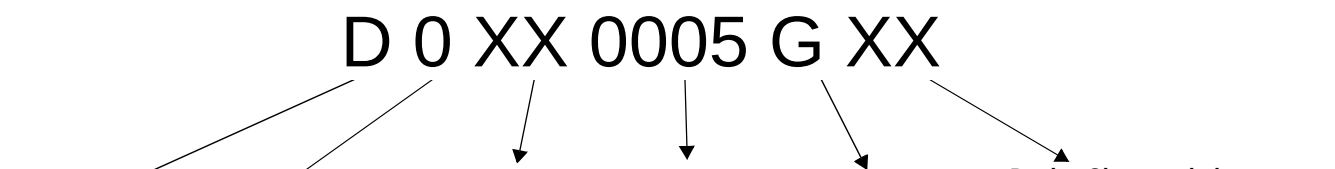
Service Requirements

Follow the service requirements listed below.

- Refer equipment servicing to GE Medical Systems *Information Technologies*'s authorized service personnel only.
- Any unauthorized attempt to repair equipment under warranty voids that warranty.
- It is the user's responsibility to report the need for service to GE Medical Systems *Information Technologies* or to one of their authorized agents.
- Failure on the part of the responsible individual, hospital, or institution using this equipment to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazards.
- Regular maintenance, irrespective of usage, is essential to ensure that the equipment will always be functional when required.

Equipment Identification

Every GE Medical Systems *Information Technologies* device has a unique serial number for identification. The serial number appears on the product label on the base of each unit.



Month Manufactured
A = January
B = February
C = March
D = April
E = May
F = June
G = July
H = August
J = September
K = October
L = November
M = December

Year Manufactured
0 = 2000
1 = 2001
2 = 2002
(and so on)

Product Code
Two-character product descriptor

Product Sequence Number
Manufacturing number (of total units manufactured.)

Division
F = Cardiology
G = Monitoring
N= Freiburg Hellige

Device Characteristics
One or two letters that further describe the unit, for example:
P = prototype not conforming to marketing specification
R = refurbished equipment
S = special product documented under Specials part numbers
U = upgraded unit

For your notes

2 Equipment Overview

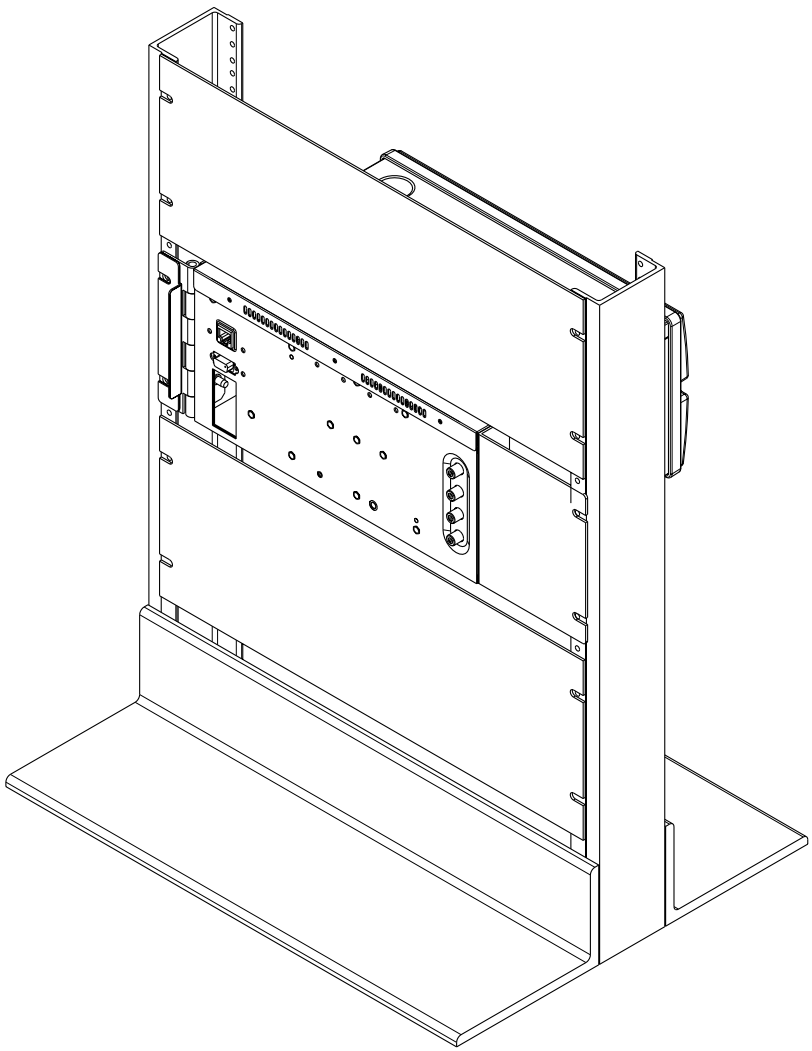
For your notes

Receiver System Overview

The receiver system's function is to selectively receive, demodulate, and decode a specified patient's data that has been transmitted from a transmitter and broadcast on the RX network to the host application. Patient data is not stored here. The system only knows TTX numbers assigned from the host and forwards data to the host where a patient name is assigned.

The receiver system receives RF signals from the four antenna inputs. These inputs are for four separate, overlapping fields. The system performs the following functions:

- filters RF (backplane)
- distributes RF to quad receiver modules (backplane)
- demodulates and decodes transmitter data (quad receiver modules)
- retrieves decoded data (backplane)
- packetizes and sends data out over RX Ethernet (backplane)



Antenna System Overview

The function of the antenna system for telemetry is to offer transmitted signal coverage of a prescribed telemetry area. In addition, the antenna system should provide error-free reception of the transmitted data by the receiving system.

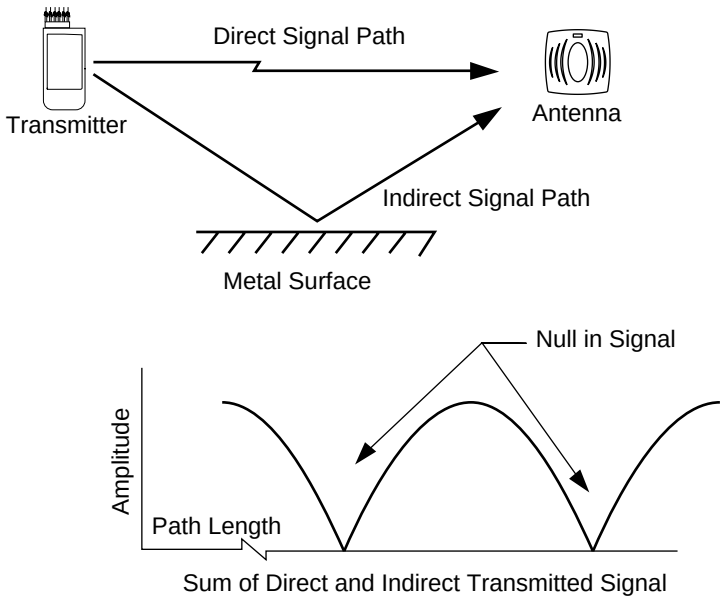
Some advantages of a GE Medical Systems *Information Technologie*s antenna system are:

- handling multi-path signal interference by using a diversity style antenna system,
- using home runs versus daisy chain style antenna cable runs.

These topics are detailed in the following sections along with some information on signal-to-noise ratio and an introduction to some of the main components used in an antenna system.

Multi-Path Signals

In an indoor environment, many signal paths exist between the transmitted signal and the receiving antenna. This is due to signal reflections from metal ceilings, metal walls, metal carts, and other reflective mediums. These reflected signals have different path lengths from the transmit device to the receiving antenna as compared to the direct signal path. If this indirect path is in the proper phase and amplitude when compared to the direct path, the indirect signal cancels the direct path signal. Refer to the figure below. As the path length changes, the signal cancellations (or nulls) also change and cause a dynamic multi-path environment.



Diversity

Diversity is defined as different or a difference. For a telemetry system, this difference is a different antenna connection or antenna field to obtain the telemetry signal. This different antenna connection is used to reduce the effects of multi-path signal cancellation (drop-out). There must be at least two different antenna systems or antenna fields for a diversity antenna system. The ApexPro Antenna System provides up to four antenna fields to provide diversity.

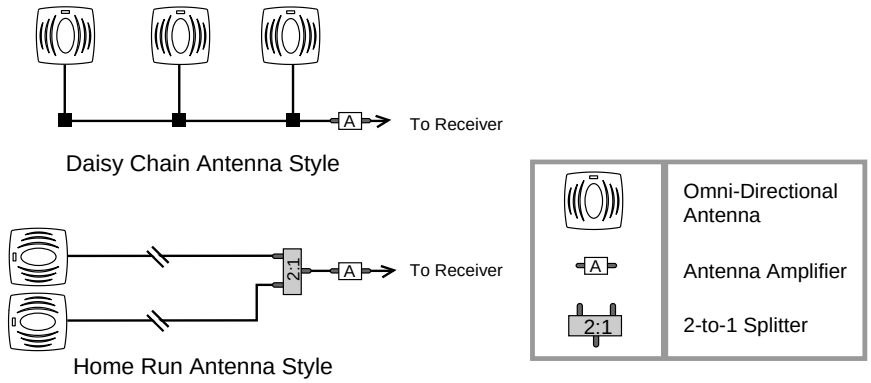
In the ApexPro Telemetry System diversity scheme, each telemetry receiver is continuously monitoring all four antenna fields. When a stronger antenna field is detected, the receiver switches receiving antenna fields to the stronger field. This feature results in the reduction of the effect of multi-path signals for a given receiving antenna field and provides a seamless switch between antenna fields.

Signal-to-Noise Ratio

The signal-to-noise ratio is described as the level of the received signal compared to the level of the received noise. The detector in the receiver that recovers the digital data from the RF signal needs a given signal-to-noise ratio in order to operate error-free. The greater the signal-to-noise ratio above this minimum level, the better the detector operates. In an antenna system, the signal-to-noise ratio is determined by the amount of RF noise in the coverage area, the amplitude of the received signal, the amount of noise added by any amplifier stages in the antenna field, and the number of antennas connected to the antenna field. A related term is the noise floor. Generally speaking, the lower the noise floor, the greater the signal-to-noise ratio is for a given receive signal.

Home Run vs. Daisy Chain Connections

ApexPro Antenna System is based on the active home run style. This means that each antenna has its own cable run returning to the receiver system. This is in contrast to the daisy chain style connection where many antennas are connected together in a star format before connecting to the receiver system. Although the home run style system uses more antenna cable, it is easier to troubleshoot and easier to isolate individual antenna runs that have a high noise level.



Wireless Medical Telemetry Service

In June 2000 the Federal Communications Commission (FCC) allocated new spectrum and established rules for Wireless Medical Telemetry Service (WMTS) allowing potentially life-critical equipment to operate on an interference-protected basis.

The frequency allocation for WMTS provides spectrum where the equipment can operate on a primary basis, increasing the reliability of this important service. The FCC allocated 14 MHz of spectrum for use by medical telemetry equipment in the 608-614 MHz, 1395-1400 MHz, and 1429-1432 MHz bands. This allocation was based on a needs assessment conducted by the American Hospital Association (AHA).

The 608-614 MHz band, which corresponds to TV channel 37 had been reserved for radio astronomy uses, so this action elevates medical telemetry to a co-primary status with radio astronomy in this band. The 1395-1400 MHz and 1429-1432 MHz bands were government bands reallocated for non-government use.

Medical telemetry equipment was operating on a secondary basis either on vacant TV channels under Part 15 of the rules or on special channels reserved for low-power operation under Part 90 of the rules. It was unprotected from interference from primary users. This action increases the reliability of medical telemetry equipment by making them co-primary users in their allocated band.

WMTS is designated as one of the Citizen's Band Services in Part 95 of the rules and licensed by rule to eliminate the possible costs and delays to obtain individual operator's licenses. The medical telemetry equipment is authorized under the certification procedure in Part 2 of the rules. One or more frequency coordinators maintain a database of all equipment used in conjunction with WMTS.

For more information visit http://www.fcc.gov.

Electromagnetic Compatibility Compliance

Radiated RF Immunity Verification Results

The ApexPro Telemetry System meets the requirements of EN60601-1-2 (1993-04) Medical Electrical Equipment, Part 1: General Requirements for Safety, 2. Collateral Standard: Electromagnetic compatibility – Requirements and tests, with the following exceptions.

NOTE: This data was collected December 6 - 8, 1999.

Exceptions

EN60601-1-2 Second Edition Draft 200X-YY clause 2.210 Exclusion bands for intentional radiating/receiving devices = +/- 5% of frequency or frequency band.

EN60601-1-2 Second Edition Draft 200X-YY clause 36.202.3 - a - 4 – Radiated RF Electromagnetic fields Immunity - Exclusion Band

EN60601-1-2 Second Edition Draft 200X-YY clause 36.202.6 - a - 4 – Conducted RF Electromagnetic fields Immunity - Exclusion Band

- The antenna system tested operates in a frequency band of 560 - 614 MHz. The allowable exclusion band would then be 532 - 645 MHz. The level of compliance is not 1 V/m in the ranges of 520 - 534 MHz and 645 - 660 MHz.
- The transmitter tested operates at a frequency of 614 MHz. The allowable exclusion band would then be 583 - 645 MHz. The level of compliance is 1 V/m.

If operating under the conditions defined in EMC Standard EN60601-1-2 (Radiated Immunity 3 V/m), field strengths above 1 V/m may cause waveform distortions and erroneous numeric data at various electromagnetic interference (EMI) frequencies.

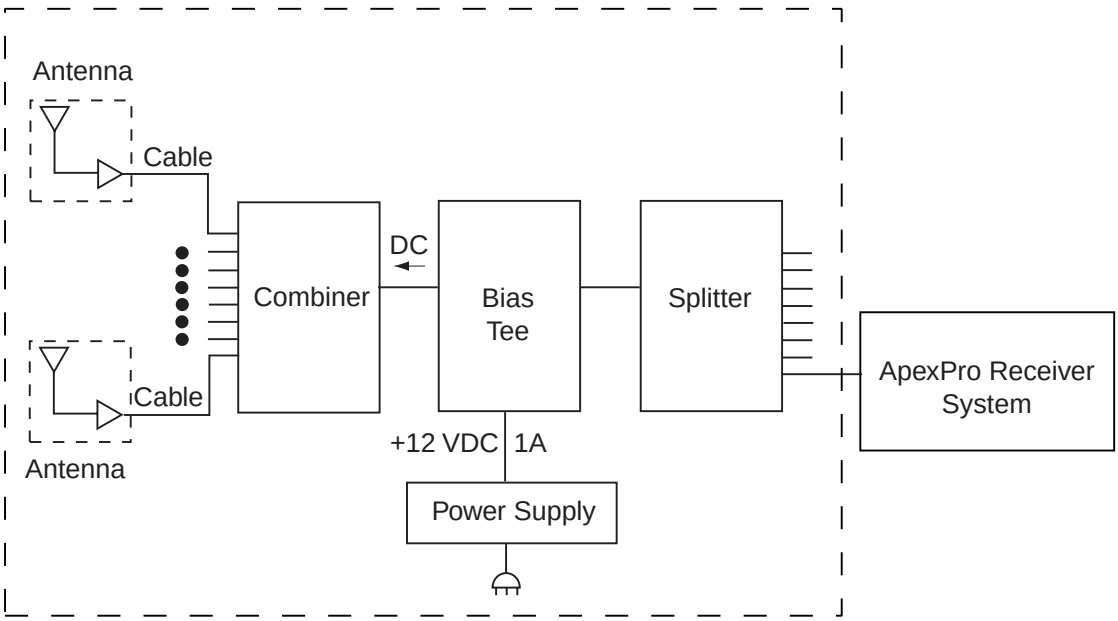
Recommendations

- Review the AAMI EMC Committee technical information report (TIR-18) titled Guidance on electromagnetic compatibility of medical devices for clinical/biomedical engineers - Part 1: Radiated radio-frequency electromagnetic energy. This TIR provides a means to evaluate and manage the EMI environment in the hospital.
- The following actions can be taken:
  - Manage (increase) distance between sources of EMI and susceptible devices.
  - Manage (remove) devices that are highly susceptible to EMI.
  - Reduce power from internal EMI sources under hospital control (i.e., paging systems).
  - Label devices susceptible to EMI.
  - Educate staff (nurses and doctors) to be aware of and to recognize potential EMI-related problems.

Antenna System Components

The antenna system components include receiver antennas, amplifiers, antenna combiners/splitters, attenuators and antenna notch filters as needed, and DC power sources to power the receive antennas and antenna amplifiers. See the Parts Lists chapter for specific part numbers and descriptions.

The ApexPro Antenna System is not compatible with any previous telemetry systems due to the change in operating frequency.



Power Requirements

The DC power requirements for the ApexPro Antenna System depend greatly on the configuration of each individual system. To ease the power requirements of the ApexPro Telemetry System, the power supply for the antenna system is external to the ApexPro Receiver System and separate from the antenna.

A power supply with 12Vdc 1A output is used in conjunction with a bias tee. One power supply minimum per antenna field with a maximum of 18 antennas/antenna amplifiers per power supply. If there are more than 18 antennas/antenna amplifiers per field, then segment the antenna field and divide the load of the antenna/antenna amplifiers to another power supply and bias tee. (Refer to the Signal Loss Chart on page 3-29.)

Interface with ApexPro Telemetry System

The interface between the antennas and the receiver system consists of coaxial cabling and connectors for transferring the transmitted signal. The interface uses 75 ohm cable from each antenna field and 'F' style 75 ohm connectors as a connection medium. The preferred cable is RG-6, but for longer lengths RG-11 may be used.

Interface with Multiple ApexPro Telemetry Systems

To interface the antenna system with multiple ApexPro Receiver Systems, each antenna field in the antenna system is split into the appropriate number of tap points using combiners/splitters before connecting to each ApexPro Receiver System.

Receiver Antenna System

Each receiver antenna system is custom designed based on the coverage area and the location of the ApexPro Receiver System. Many factors determine the type of antenna system designed. The number of antenna fields needed must also be determined based on the specifics of the installation. See chapter 3, Site Survey and Antenna System Design for details.

Receiver Antenna

The receiver antenna is a circularly-polarized array of sloping half-wave dipoles. It exhibits an omni-directional coverage pattern and includes and active amplifier. The amplifier supplies 17dB of signal gain and draws approximately 55mA from as low as 8Vdc.

The receiver antenna comes with a standard drop ceiling T-bar mount. Refer to chapter 7, Parts Lists and Drawings for other mounting options.

Antenna Amplifiers

The antenna amplifier boosts the signal when losses from other antenna components exceed the gain of the receiver antenna. It supplies 22dB signal gain and draws approximately 55mA from as low as 8Vdc. The antenna amplifier is dc passive and can pass up to 1A from input to output.

Coaxial Cable

Coaxial cabling is used to connect the omni-directional antennas and cable amplifiers to the receiving equipment. Controlled impedance cabling is used and 75 ohm RG-6 type is recommended. Plenum or riser rated cable is used to meet NEC fire codes. RG-11 may be used if cable lengths become long and dB losses become excessive.

Splitters/Combiners

Passive splitters/combiners split or combine the RF signal into multiple paths. The same splitter may also be used as a combiner to join multiple RF signals into one path. There are two, four, or eight way splitters available that are DC passive. All unused ports must be DC blocked and 75 ohm terminated.

Attenuators

Attenuators lower signals and balance antenna runs. The attenuators are DC passive and are available as 3 dB, 6 dB, 10 dB, and 20 dB attenuators.

Power Supply

A +12Vdc power supply at 1A supplies power to the antenna system. Power supplies accept AC voltages between 90-270Vac. AC inputs have internal fuses that are not replaceable. The output of the supply is short circuit protected.

Bias Tee

The antenna bias tee allows the injection of DC power from the antenna power supply into the antenna system cabling. The bias tee supplies RF isolation between the RF signals on the antenna cabling and the power supply. It contains a DC block that blocks the conduction of dc power to the receiver system and associated hardware.

Use a bias tee with each power supply.

Notch Filters

Notch filters are channel specific and notch out the TV video and audio signals. Notch filters may be required to attenuate strong analog or digital TV stations between 560–614MHz if the signal levels are above -50dBm.

3 Site Survey and Antenna System Design

For your notes

Overview

CAUTION
Use this manual only as a guide for the design and installation of a telemetry antenna system. This manual does not predict or take into account all of the installation environmental conditions affecting the design and installation of a specific antenna system. Using this manual does not guarantee successful operation of an antenna system. If there are specific concerns about design or installation, contact GE Medical Systems *Information Technologies* technical support personnel.

CAUTION
Unintentional Radio Frequency (RF) Interference — Unintentional RF interference could degrade the reliability and performance of the wireless data link. The facility must maintain an RF environment free from unintentional interference.

The following is a summary of the steps necessary to complete an ApexPro Antenna System site survey and system design. This summary assumes that sales has received the order and arranged for a site survey with a telemetry installation specialist.

- complete planning steps
- hold roundtable meeting
- perform a walk-through
- complete a penetration check
- design the system
- complete the antenna logical schematic layout
- document the survey

  The following is a summary of the installation specialist's responsibilities when documenting a site survey.

  - Mark the antennas according to the site surveys and scaled drawings.
  - Generate a bill of materials from the designed schematic and order parts to be sent to the site.
  - Create a schematic diagram of the antenna system.
  - List all installation process details.

Planning Steps

Before performing a site survey, the antenna system must be carefully planned and designed. For a typical antenna system site, make sure the following steps have been completed.

1. Sales personnel has a confirmed and quoted antenna coverage area.
2. Sales personnel asks the customer for scaled drawings of all telemetry coverage areas and schedules the roundtable meeting.
3. U.S. Only

- Installation specialist determines if channel 37 (608-614MHz) can be used. See Appendix D, Radio Astronomy Sites, for details.
- Installation specialist determines if there are any other users of channel 37 by contacting frequency coordinator.
- Contact Monitoring Technical Support at 800-558-7822 for an ApexPro Telemetry System survey kit and spectrum analyzer.

3. International

- Installation specialist determines if frequencies between 420-474MHz can be used.

Roundtable Meeting

An on-site roundtable meeting organized by sales, is recommended and used as a transfer point from sales to the installation specialist. Listed below are the people required to attend the roundtable meeting.

- plant manager of maintenance
- manager of biomedical engineering department
- director of nursing
- unit nurses of all coverage areas
- monitoring salespeople
- IS department head, if required

The purpose of the roundtable meeting is to:

- review the sales order
- verify all telemetry coverage areas
- identify equipment location
- verify whether plenum or non-plenum cable is required
- verify the responsibility for coaxial cable installation, and
- determine ship and delivery dates of all equipment,
- review any other RF emitter in the community.

Walk-Through Criteria

Complete a walk-through with all roundtable meeting attendees using the following important criteria to plan and design the antenna system.

Scaled Drawings

The first and most important requirement for antenna layout planning is a scaled drawing of the antenna coverage area of the hospital. It is essential that all areas of telemetry coverage be clearly marked on these scaled drawings such a patient rooms, hallways, and any remote areas.

Coaxial Cable Requirements

The National Electric Code (NEC) fire rating for the coaxial cable must be identified and documented. To fulfill NEC codes, you should use either riser-rated or plenum-rated coax.

Fire Code Compliance

The National Electric Code requires the coaxial cable installed in non-residential buildings to comply with strict fire codes. Consider the following requirements.

WARNING
Fire Hazard. Check and comply with all local fire codes before installation.

Ducts and Air-Handling Spaces

Cabling installed in air-handling spaces poses a potentially dangerous condition in the event of a fire. Air ducts typically run unobstructed throughout the hospital, and any flame or smoke generated by wire and cable products spreads very quickly. Cabling installed in these air-handling spaces must pass the NFPA 262 (or UL-910) flame test. Use plenum cabling for this application.

Vertical Shafts and Non-Air-handling Spaces

Non-air-handling spaces include vertical shafts such as elevator shafts. Cables installed in such locations must pass the Vertical Riser Flame test of UL-1666. Use riser cabling for this application.

Splitter and Power Supply Location

Identify a central location in the telemetry coverage area to mount the splitters, preferably a communication closet for ease of installation and troubleshooting. This is also the termination location for all of the antennas.

For multi-floor antenna coverage, it may be best to have a splitter location per floor to reduce cable run distances and aid the balance of the antenna system. Locate the splitter centrally near cable feed-throughs.

The power supply and bias tee location depends on antenna loading per power supply. See "Power Supply Design" on page 3-17. Generally, it is best to have splitters and power supplies mounted to plywood (must meet fire codes) for ease of tuning the system or troubleshooting.

Equipment Location

You must indicate the location of the telemetry Receiver Systems, central stations, and any other optional equipment on the scaled drawings. This information is essential for planning coaxial cable lengths and antenna locations. Design the antenna system so antennas are not mounted near electronic devices. Some devices generate radiated emissions.

- Use a dedicated connection between the Receiver System RX network and the CIC with ApexPro.
- If the distance between the CIC with ApexPro and the Receiver System is less than 100 meters (328 ft.), then use point-to-point with crossover cable (null modem) connection.
- If the distance is greater than 100 meters (328 ft.) then use either an additional hub or use fiber optic cable.

NOTE: Do not connect multiple Receiver Systems on the Unity MC, IX, or RX networks. A dedicated network is critical because it is real-time unprocessed patient data.

Room Construction

The construction of the rooms must be provided for antenna system planning. Location of patient bathrooms with respect to hallways and accessibility to the ceilings above the rooms for the installation of the coaxial cabling must be identified on the scaled drawings. This information helps in determining the antenna spacing and the location of the antennas for easy installation.

Hospital Construction

The building materials used in the construction of the hospital's infrastructure are important for design planning. Any metal lathe walls, metal ceilings, fire stop requirements in the walls, or any other special requirements must be indicated on the scaled drawings. This helps determine the placement of the antennas and the spacing between antennas. It also determines any special cable installation considerations or procedures.

Number of Floors

In some instances, more than one floor is specified for antenna coverage. Cable feed-throughs must be identified on the print. This information must be provided and clearly marked on the scaled drawings to aid in the location and connection of the antennas and to determine the type of coaxial cabling used.

RF Interference

Using a spectrum analyzer, indicate all electrical noise sources (such as personal computers, televisions sets, electrical switching devices [elevator controls, etc.], and fluorescent lights) on the scaled drawings. When designing the antenna system for coverage, place the antennas as far from the noise sources as possible while maintaining telemetry coverage.

Identify Noise Sources

List all TV stations (analog and digital), identify which ones are DTV and analog stations, and note the signal strength of each. Order appropriate notch filters if signals are above –50dBm. Order one notch filter per field, per channel.

Install notch filters between the bias tee and the receiver system where there is no DC voltage. Notch filters do not pass DC and may cause component damage if installed improperly.

Penetration Check

The installation specialist performs the following:

- a penetration check to determine antenna coverage,
- a sweep of frequencies to identify all local television stations coming in greater than –50dBm and to identify other noise sources for the area. Use the TV Channel Frequency Chart in Appendix B as a reference for TV channels and frequency assignments.

Perform this procedure after the walk-through with all meeting attendees to estimate the signal losses of the construction material and to help determine antenna spacing.

Contact Monitoring Technical Support at 800-558-7822 for an ApexPro Antenna System survey kit and spectrum analyzer.

NOTE: The penetration check requires two people and the layout scaled drawings of the hospital.

NOTE: Refer to spectrum analyzer operator's/user's manual for correct operation of the device.

Equipment

The following equipment is needed to perform the penetration check:

- spectrum analyzer 20 – 900 MHz
- patient simulator
- two AA batteries
- ApexPro Antenna System Survey Kit

The following equipment is not required, but helpful when performing the penetration check:

- extension cord (for analyzer and power supply)
- two-way radios
- six foot step ladder
- flashlight

ApexPro Antenna Survey Kits

2005352-003, U.S

Item Number	Item Description
APROTX-US-ENG-AHA-1	APEX PRO TRANSMTR USA ENG AHA 584-614MHZ
421932-001	AHA 6LDWR SET GRAB 29
2000673-003	ASSY APEXPRO ANTENNA 560-614 MHZ
401904-001	CABLE ASM COAX NPLN BLK 10FT

2005352-004, International

Item Number	Item Description
APROTX-CH-GER-IEC-3	APEX PRO TRANSMTR CH GER IEC 420-460MHZ
421932-001	AHA 6LDWR SET GRAB 29
2000673-005	ASSY APEXPRO ANTENNA INTL 420-474 MHZ
401904-001	CABLE ASM COAX NPLN BLK 10FT

NOTE: Outside the U.S. you must purchase a power cord for the power supply.

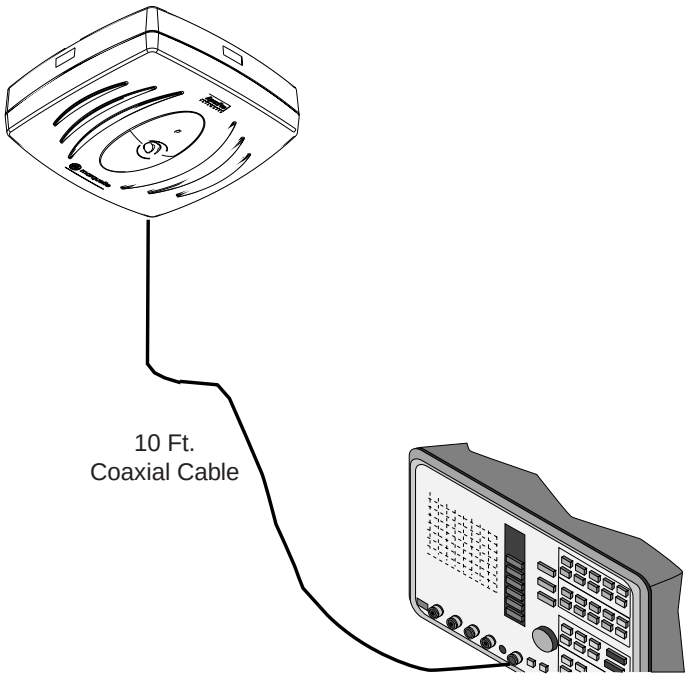
Spectrum Analyzer Settings

Model HP 859X	
Center Frequency =	Center frequency of transmitter
Span =	250kHz
Reference Level =	-50dBm
Attenuation =	0dBm
Resolution Bandwidth =	10kHz
All other menus at default	

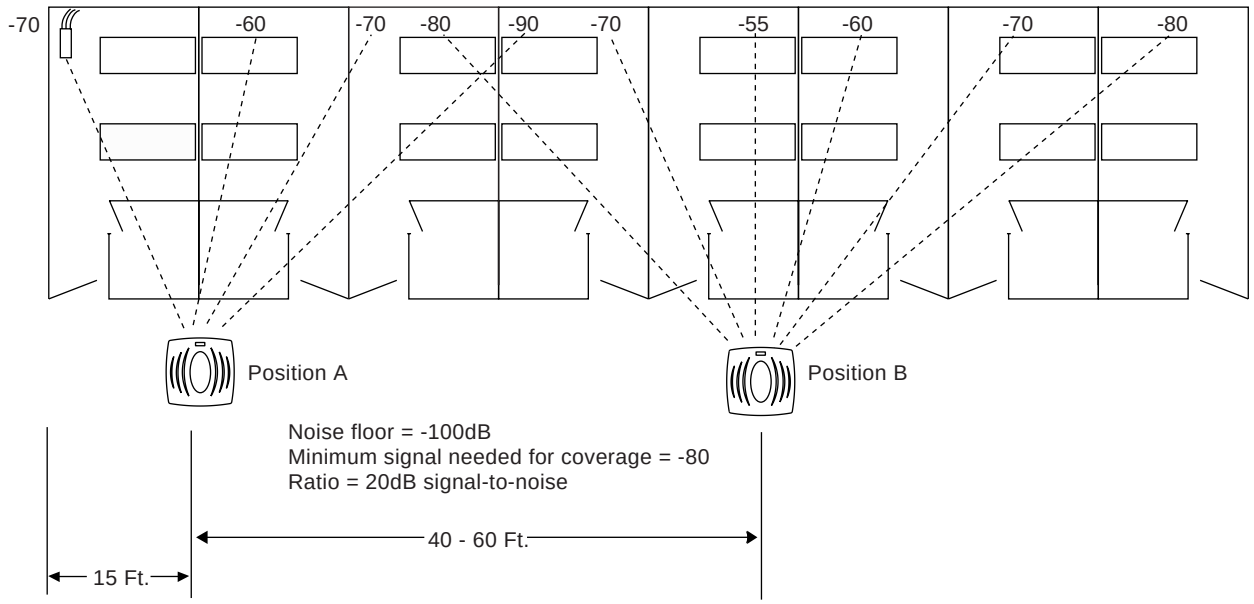
Model ESA-L1500A	
Center Frequency =	Center frequency of transmitter
Span =	250kHz
Reference Level =	-30dBm
Attenuation =	0dBm
Resolution Bandwidth =	10kHz
All other menus at default	

Setup

1. Connect the spectrum analyzer to the antenna as shown below.



2. Place the antenna near the ceiling in the hallway in position A on drawing below. Start with difficult coverage areas first.



3. Connect the telemetry transmitter to the simulator using leadwires.
4. Use the TTX Frequency Chart in Appendix A to determine the transmitter's frequency and enter the frequency into the spectrum analyzer.

Define the Antenna Coverage

1. On the print, record the transmitter peak value around the antenna. Also record the value of the noise floor.
2. Have the first person hold the transmitter chest high and walk along the furthest wall of the rooms while turning the transmitter away from the test antenna. The signal level needs to maintain a 20dB signal-to-noise ratio above the noise floor and a signal level at or greater than –80dBm.
3. Walk the area of coverage until 20dB signal-to-noise is marginal or signal drops below –80dBm. Record the dB signal levels on the print in the coverage area when the signal drops below 20dB signal-to-noise.
4. Move the antenna to position B and repeat the steps above to determine penetration of the RF signal. The outcome determines antenna spacing.
5. Perform several penetration checks and several antenna positions if the hospital infrastructure is inconsistent in the coverage area.

Identify Strong Signals

1. Set up the ApexPro antenna survey kit near a window of the outlying area of coverage.
2. Identify and measure RF signals of the local TV stations and strong signals. Record the values of these signals in the TTX Frequency Chart in Appendix A. Any signals at or above –50dB require the installation of notch filters at the receiver system. Use the TV Channel Frequency Chart in Appendix B to determine TV channels and their assigned frequencies. For signals greater that –20dBm, see the following section, “Choose Antenna”.

   The table below identifies notch filters to order when strong signals are present.

For channel..	order this filter
Below Channel 26	high pass
26 – 41	channel 26 – 41 notch
Above 41	low pass

In the U.S. visit the following website for future TV stations in your community:

http://www.fcc.gov/healthnet/welcome.html

3. Repeat these steps for north, south, east, and west areas of outlying coverage.
4. Identify the channel notch filter required and order one for each channel for each antenna field.
5. Disconnect all test equipment.

Choose Antenna

560-614MHz

Choose the ApexPro Antenna (see chapter 7, Parts Lists and Drawings for part numbers) unless,

- the IMPACT.*wf* paging system is used within the telemetry coverage area. Then install high power (HI PWR) antennas to avoid compression.
- noise source(s) is stronger than –20dBm. Then install passive antennas and order appropriate notch or high/low pass filter for each antenna effected by strong signals.

NOTE: Do not use the passive antenna for general installations. This part is reserved for special cases.

Description	Gain (dB)	Filter	Minimum Voltage Required	Current Draw
ApexPro antenna	17	No	+6V	40mA
Hi-Pwr antenna	17	Yes	+8V	55mA
Passive antenna	–5	No	0	0

NOTE: Order extra connectors and dc blocks when using passive antennas. Notch filters do not pass dc voltage and must be installed between the antenna and an amplifier with a dc block.

420-474MHz

Choose either the high power or passive antenna from the table above using the same guidelines.

Data Summary

At this point the following data has been collected:

- telemetry coverage defined on print
- equipment location defined on print for all items on the sales order
- hospital construction identified on print
- cable feed-through identified on print
- splitter location identified on print
- electrical noise sources identified on print
- notch filters identified (determined by signal strength of local TV stations)
- antenna spacing determined by doing penetration checks.
- antenna(s) type selected for general installation
- passive antennas (if any) and notch or high/low pass filters required for avoiding strong signals.

It is now possible to design the antenna system.

Antenna System Design

When the preparation information for the antenna layout is obtained, designing the antenna system begins. With the hospital scaled drawings containing the coverage area and construction details of the hospital, the antenna locations and antenna cabling are drawn and field lengths projected. In this section, the steps involved in the actual design of the system and the location of all the antennas, cabling, amplifiers, and other miscellaneous hardware are described. This section contains a step-by-step description of the selection process to design most common antenna systems.

NOTE: The following statements are general guidelines and may be altered at installation or as dictated by the site survey.

Coaxial Cabling

The recommended coaxial cable for telemetry antenna systems is 75 ohm RG-6 cable for new and add-on installations.

- RG-6 coax cabling is the preferred choice overall, plenum or riser.
- RG-11 coax cabling should be used only if the RG-6 specifications do not qualify due to length-versus-signal loss and excessive DC voltage drop across the center conductor. Consult Technical Support before cabling other than RG-6 is used.
- Do NOT use RG-59 coax cabling as dB losses are too great in this frequency range.

Antenna Spacing

In order to position antennas on the hospital scaled drawings, the spacing of the antennas must be defined. Patient room size and hospital construction determines if the standard antenna spacing of 50 feet is used or if the antennas need to be spaced closer together or farther apart. In addition, the building construction, location of the bathrooms in the patient rooms, and the size of the patient rooms determine if you need to place additional antennas in the coverage area. Antenna spacing is determined from the signal propagation data recorded on the scaled print from the site survey.

System Design

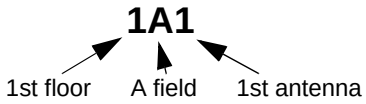
When you know the antenna cable type and determine the antenna spacing, you can begin the design and layout of the antenna system. The ApexPro Telemetry System uses a diversity scheme with up to four different antenna field inputs. The minimum number of separate antenna fields to obtain diversity is two.

Antenna Fields

Each antenna field may contain several antennas connected together to form one field. Each field is designed to work along with the rest of the antenna system to provide signal coverage for the entire telemetry area while minimizing the noise level of the system. The number of fields chosen (2, 3, or 4) is based on the size of the coverage area and the level of the noise found in the that area. In the following pages, various antenna fields are presented and the guidelines on their usage is discussed.

NOTE: Do not put two like fields next to each other. For example, do not place two A field antennas next to each other. Instead, reconnect the adjacent antenna to another field and relabel to prevent signal nulls from signal multipaths.

Give each antenna a unique label. For example:



Antenna Runs

The term 'run' is used in this manual when referring to the multiple branches connected together into one field. Each run of an antenna field may contain an antenna, cable amplifier, or attenuators based on the cable length and signal strength. The individual antenna runs are then connected into one field. In contrast, a field is the entire antenna system connected to one IN connector of the receiver system.

Power Supply Design

NOTE: If using bias tee pn2001546-001 you must use GE Medical Systems *Information Technologies* power supply pn422766-001.

NOTE: Exceeding 18 antennas and amplifiers per power supply could cause antenna component damage on that field.

Power supplies with bias tees can be placed almost anywhere in the antenna system field. Many antenna components have 1A current limit and they could be damaged if current exceeds their ratings. Therefore, the maximum number of antennas and amplifiers per power supply is 18. If the antenna field has more than 18 antennas or amplifiers, then segment the field to use two (or more) power supplies. It may be helpful to segment the field by floors using a set of power supplies per floor.

Recommended Antenna Layout Design

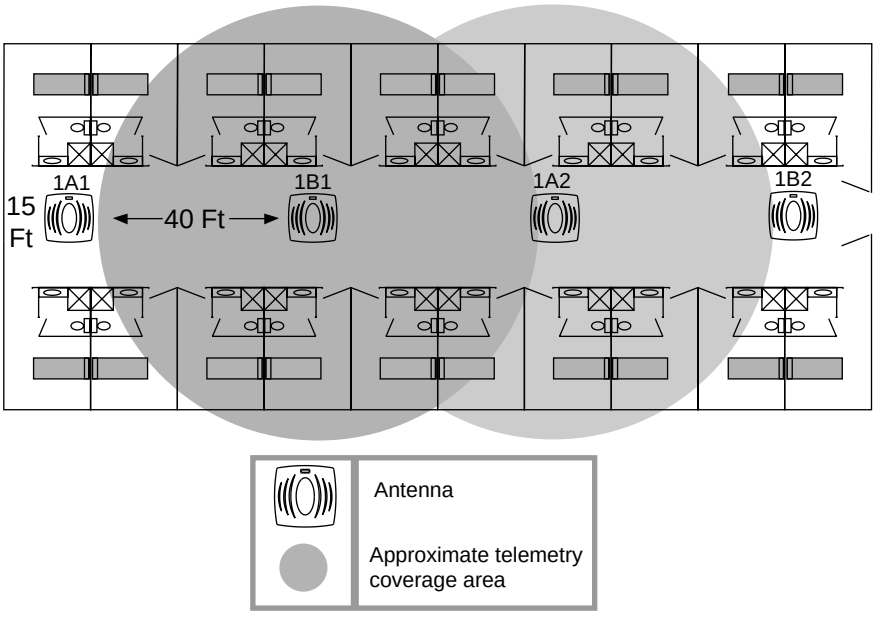
Depending on the recommendations of the site survey, one or more types of antenna field design is implemented. More details about each of the following types of antenna field design are described on the next pages.

- standard antenna design
- hallway antenna design
- deep-room antenna design
- multiple floor antenna design
- multiple power supplies
- multiple ApexPro Telemetry Systems

Standard Antenna Design

The following is an example of the standard antenna field that offers optimum coverage and performance for a wide range of hospital installations. This type of antenna field is recommended for small systems, large systems, and multiple floor systems consisting of patient rooms with depths of 20 feet or less. The field consists of antennas as shown below. Antenna spacing is shown as 40 feet, however the result of antenna spacing is dependent on the penetration check performed at the site survey.

NOTE: This configuration is for rooms 20-ft deep or less on the first floor.



Hallway Antenna Design

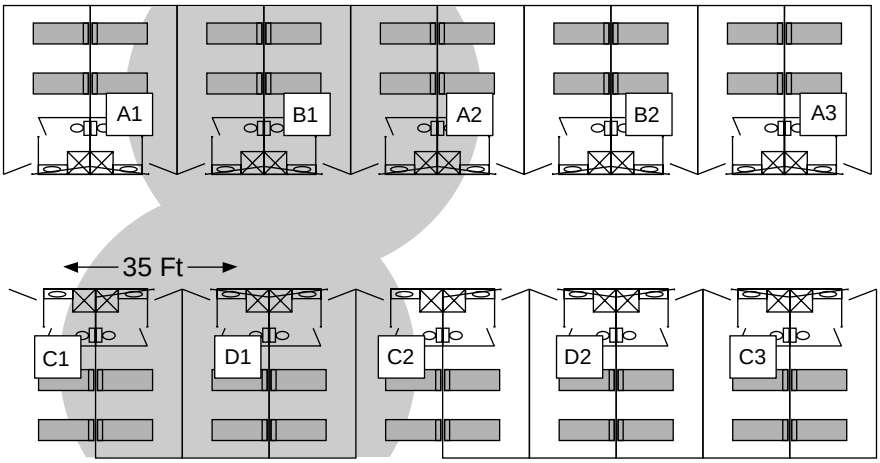
When only hallway coverage is required, it is recommended to space the antennas at intervals of 70 feet apart in the center of the hallway. Keep antennas away from lights, exit signs, and speakers.

Deep-Room Antenna Design

When the hospital construction or patient room depth requires more coverage than obtained using the standard antenna field, use a deep-room antenna configuration. Use this antenna design if the 20dB signal-to-noise ratio cannot be obtained from the site survey penetration check when the antenna is placed in the hallway. This may be typical for room depths greater than 20 feet.

The configuration for deep room coverage uses antennas placed in the rooms on both sides of the hallway. This configuration allows low noise floors obtained and the ability to tune individual antennas for noise and signal strength.

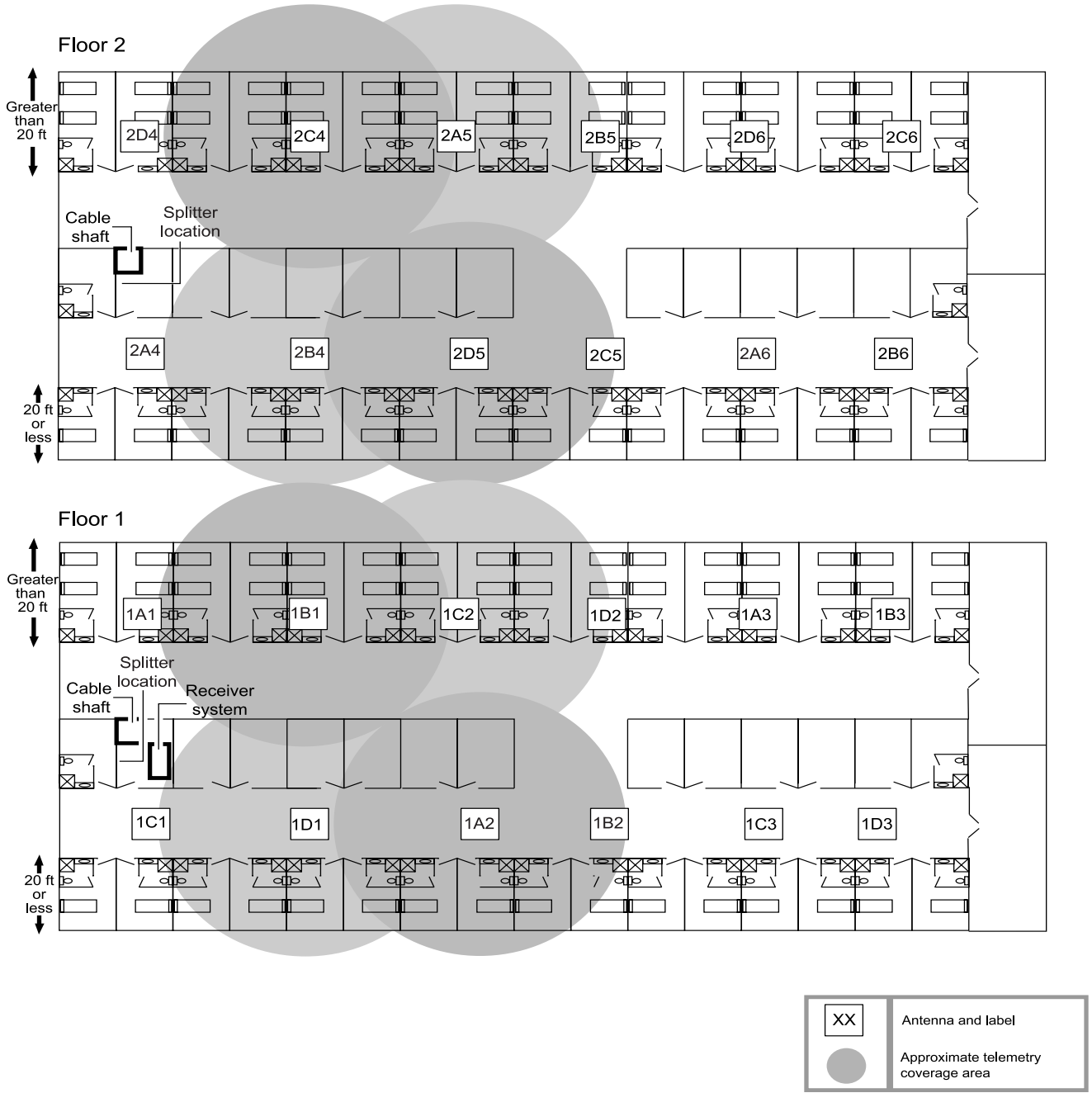
NOTE: This configuration is preferred for rooms more than 20-ft deep.



Multiple Floor Antenna Design

Use multiple floor antenna design when the hospital antenna coverage area requires more than one floor. This antenna design is a combination of the standard antenna field construction and deep room antenna design construction. Consider both guidelines discussed when you design for multiple floor antenna coverage. The following illustration is a multiple floor antenna design consisting of many antennas and long lengths of coaxial cabling. Antennas are grouped into fields and labeled as field A, field B, field C, and field D.

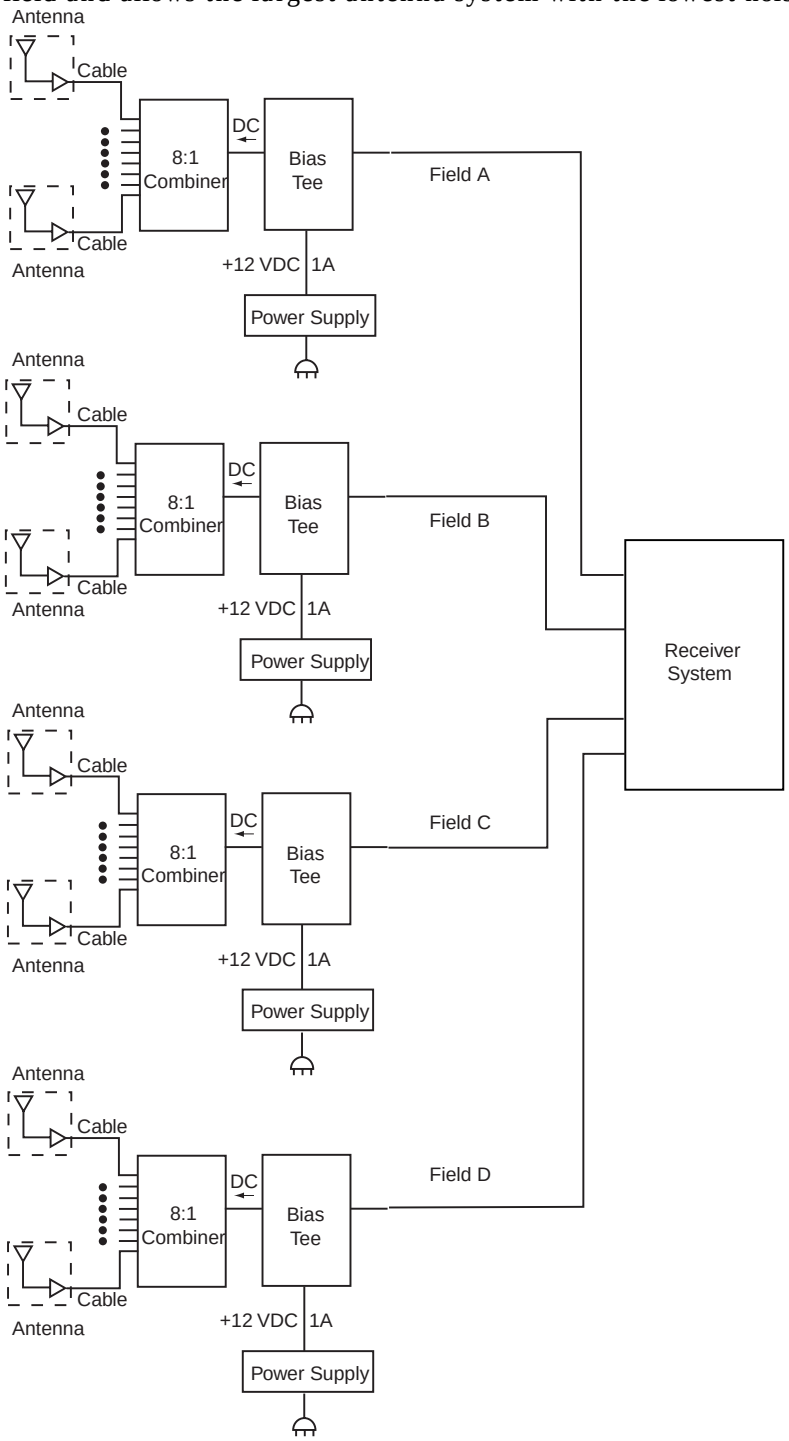
When you need multiple floor antenna systems, strategic placement of the antennas and careful selection of the antenna field for each antenna is required. For adjacent floors in the covered area, alternate antennas both in placement and in field selection as shown below. For non-adjacent floors, antenna placement and field selection is not as critical but no loss of performance is noticed if the layout continues to follow the guidelines discussed.



Antenna Logical Schematic Layout

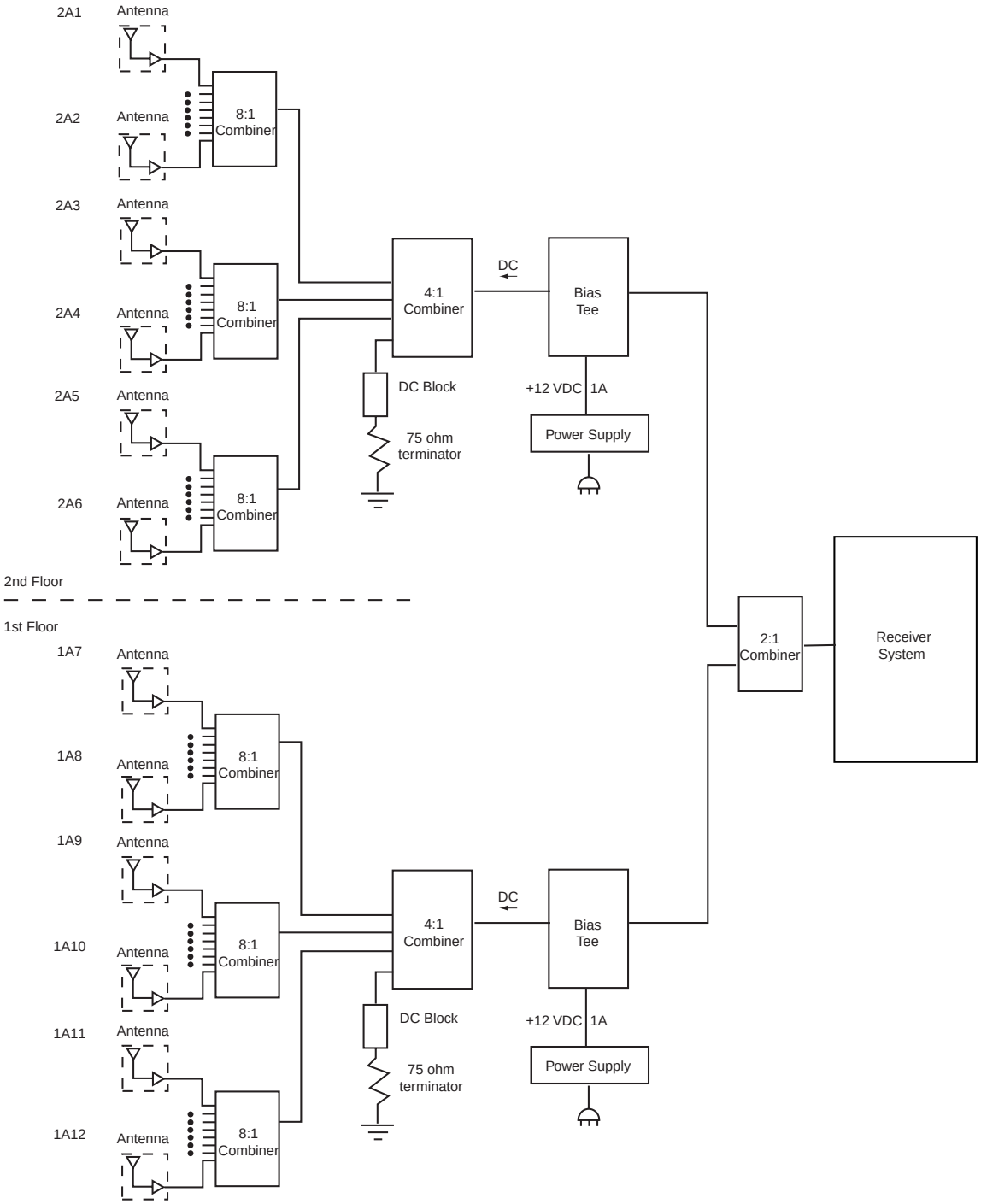
Four Field Configuration

The standard configuration of an ApexPro Antenna System is four overlapping antenna fields that connect at the ApexPro Receiver System. Using a four field antenna system maximizes coverage by each antenna in the field and allows the largest antenna system with the lowest noise.



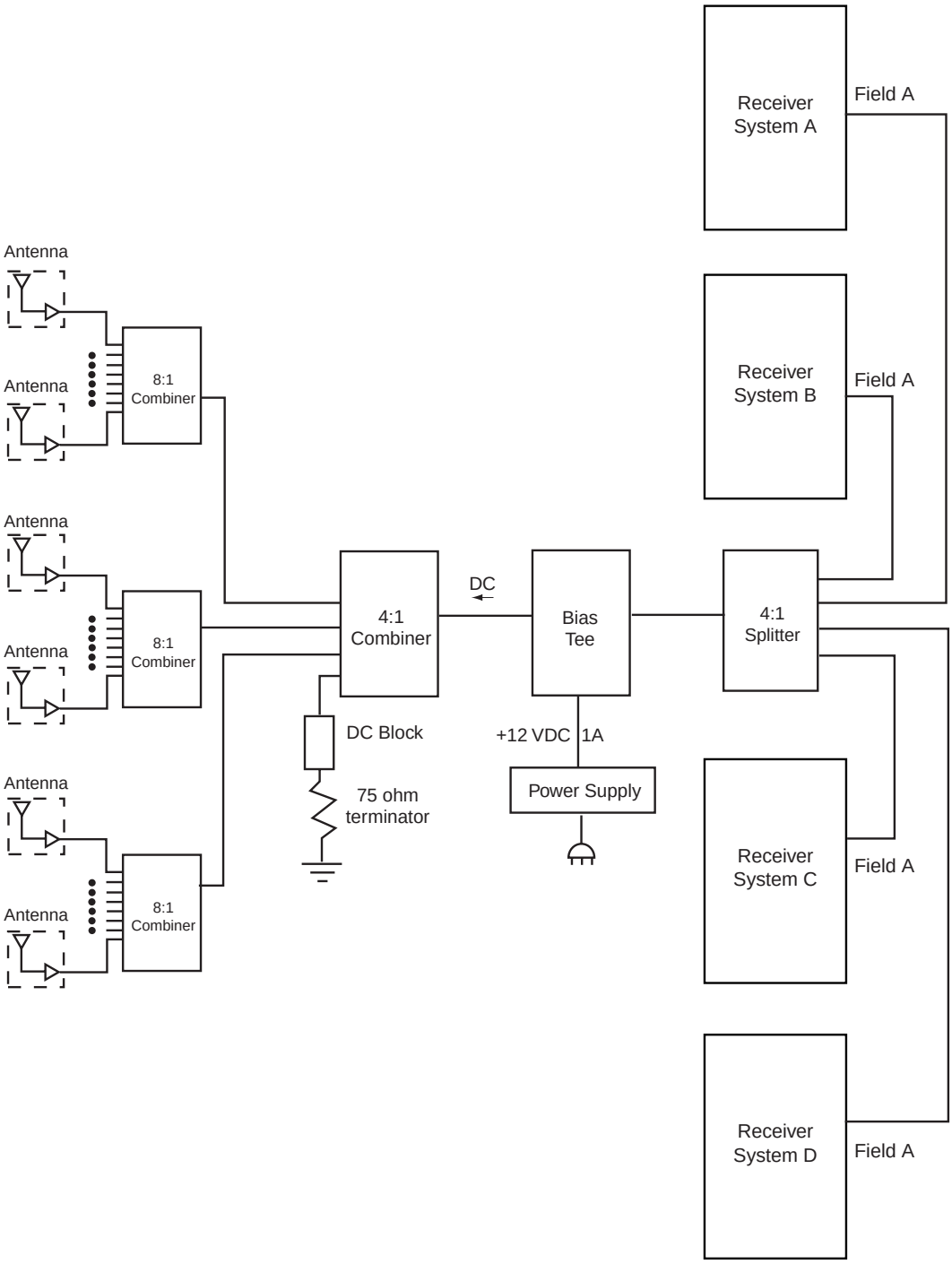
Multiple Power Supply Configuration

If an antenna system coverage area has more than 24 antennas and antenna amplifiers per antenna field, more than one power supply is required for each antenna field. Multiple sections of an antenna field can be combined to create larger antenna fields using more than one power supply. The antenna field sections must be combined on the **RF OUT** port of the bias tee to prevent the multiple power supplies from being connected together.



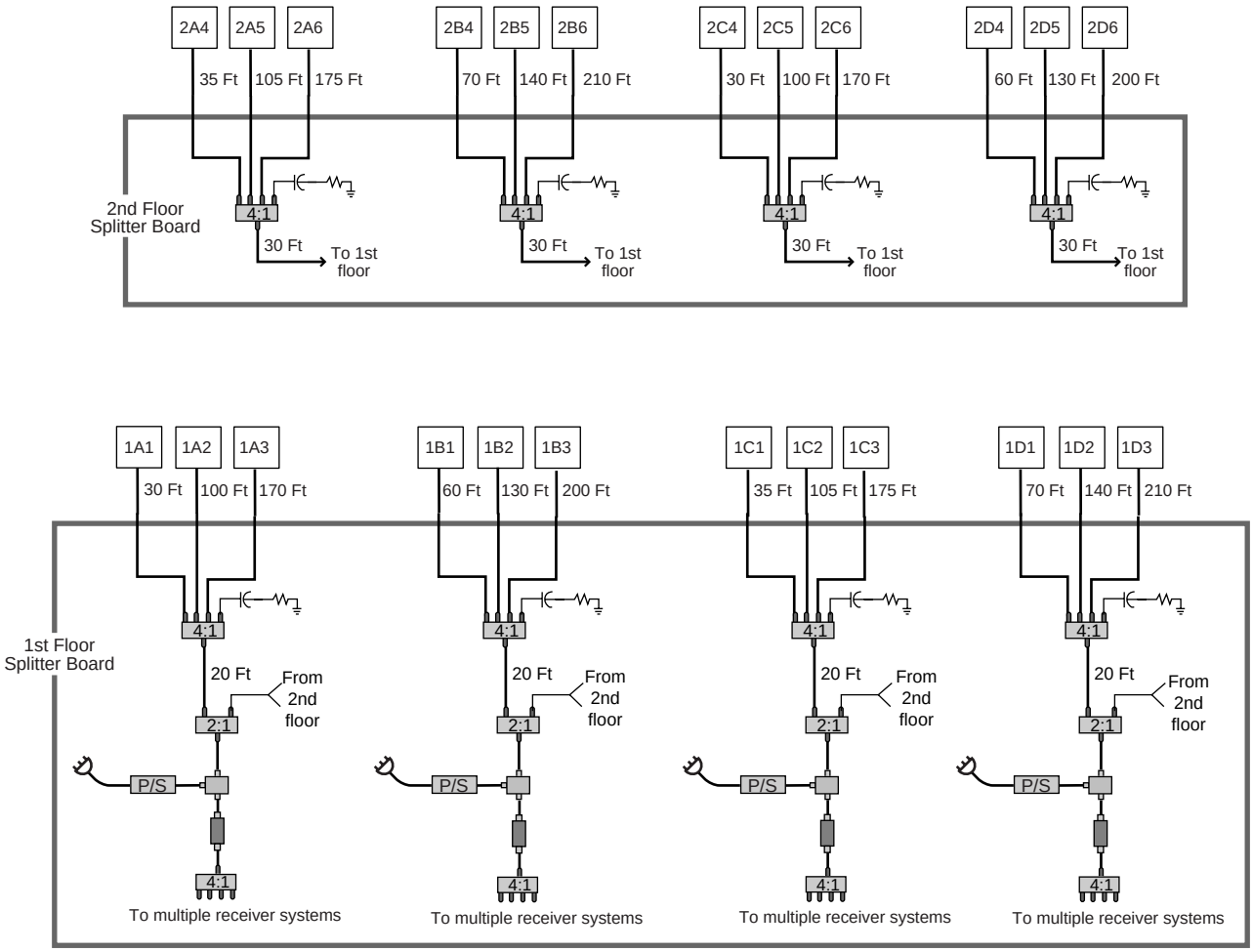
Multiple Receiver System Configuration

When an ApexPro Antenna System supports more than one ApexPro Receiver System, each antenna field must be split to each of the receiver systems. The following block diagram shows one field split to four receiver systems. It is important to remember the loss associated with splitting each antenna field when determining the amount of amplification needed for each antenna run in the field.

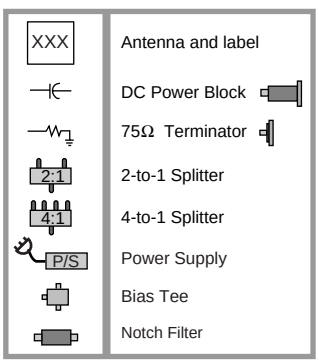


Now that the antennas are placed on the scaled print, design a logical schematic of the antenna system using the print shown on the previous page. Calculate the cable length from the antenna to the splitter location. Combine all of the same antenna fields together. Use DC blocks and 75 ohm terminator to cap any open F-connectors or splitters. In the example shown, multiple receiver systems are connected to the same antenna system.

The following is an example of the antenna logical schematic for the multiple floor design on page 3-20. Use this logical drawing and the Signal Loss Chart at the end of this chapter to determine if antenna amplifiers and/or attenuators are necessary.



Note: DC block and terminate all unused F-connectors.



System Gain/Loss Calculations

When the antenna system is designed on the scaled print and all antennas are drawn out with cable lengths on the antenna logical schematic, you can formulate system gain/loss calculations. This determines if additional amplification or signal attenuation is needed for any specific antenna run in order to balance the antenna field. In addition, you need to calculate long coaxial cable runs to ensure that the DC voltage drop from the power supply to the farthest antenna is not too large compared to the operating voltage required by the antenna.

Coaxial Cable Losses

Calculate the coaxial cable lengths for each antenna run. Calculate the run lengths from the hospital scaled drawings and the prepared antenna system schematics observing the various distances from the antennas to the receiving cabinet. To determine the signal loss of the cable run, use the following table of coaxial cable losses.

Coaxial Type	dB Loss/100 Ft @ 400 MHz	dB Loss/100 Ft @ 600 MHz
RG-6 Riser	4.0	5.1
RG-6 Plenum	4.5	5.7
RG-11 Riser	2.9	3.7
RG-11 Plenum	3.3	4.3

Splitter/Combiner Losses and Amplifier Gain

Indicate the losses of the splitter/combiners and gains of the amplifiers on the antenna system schematics. Use the specification table for splitter/combiner losses and amplifier gain given below.

Component	dB Loss/Gain	
	@ 474 MHz	@ 614 MHz
2:1 Splitter/Combiner	–4.8	–4.8
4:1 Splitter/Combiner	–8.4	–9.1
8:1 Splitter/Combiner	–15.0	–16.1
Antenna Amplifier	+22	+22

Calculate Signal Losses

When the signal gains/losses are calculated at the receiver system, amplification or attenuation may be required to balance each field so the signal levels of each antenna run are within 10dB of each other. For optimum operation, the signal at the receiver system should calculate from 0 to +10dB of gain.

Generate a Signal Loss Chart from your schematic indicating the signal gain or losses from the antenna to the receiver system. The antenna logical schematic on page 3-25 is an example of a typical antenna system design before additional antenna amplifiers and attenuation are added. The sample Signal Loss Chart shown in this section represents that design.

How to Fill Out the Signal Loss Chart

The electronic Microsoft® Excel spreadsheet with built-in formulas is available from Monitoring Technical Support. Call 800-558-7822 or go to the Monitoring Technical Support intranet site at

http://rssmast/monitoring/survey/mainsurveyhomepage.htm

After completing this chart, return it to Monitoring Technical Support with the scaled drawings and logical antenna schematic. See Appendix C for a blank chart.

NOTE: The Signal Loss Chart does not account for power supplies and bias tees. Place these in strategic locations on the logical antenna schematic to optimize powering the antenna fields.

A sample Signal Loss Chart is on page 3-29. The graphic at the top of each column of the chart illustrates the component described in that column.

1. Enter the site name at the top of the chart.
2. If you have more antennas per field than what is listed in the chart, copy and paste rows that contain formulas.
3. Using the scaled print and logical antenna schematic, enter antennas by label in the *Antenna Label* column.
4. Enter the coaxial cable length (in feet) from the antenna to the floor splitter in the *Coax length* column.
5. Select the coaxial cable type by right-clicking in the *RG-6* cell, then *Pick from List*.

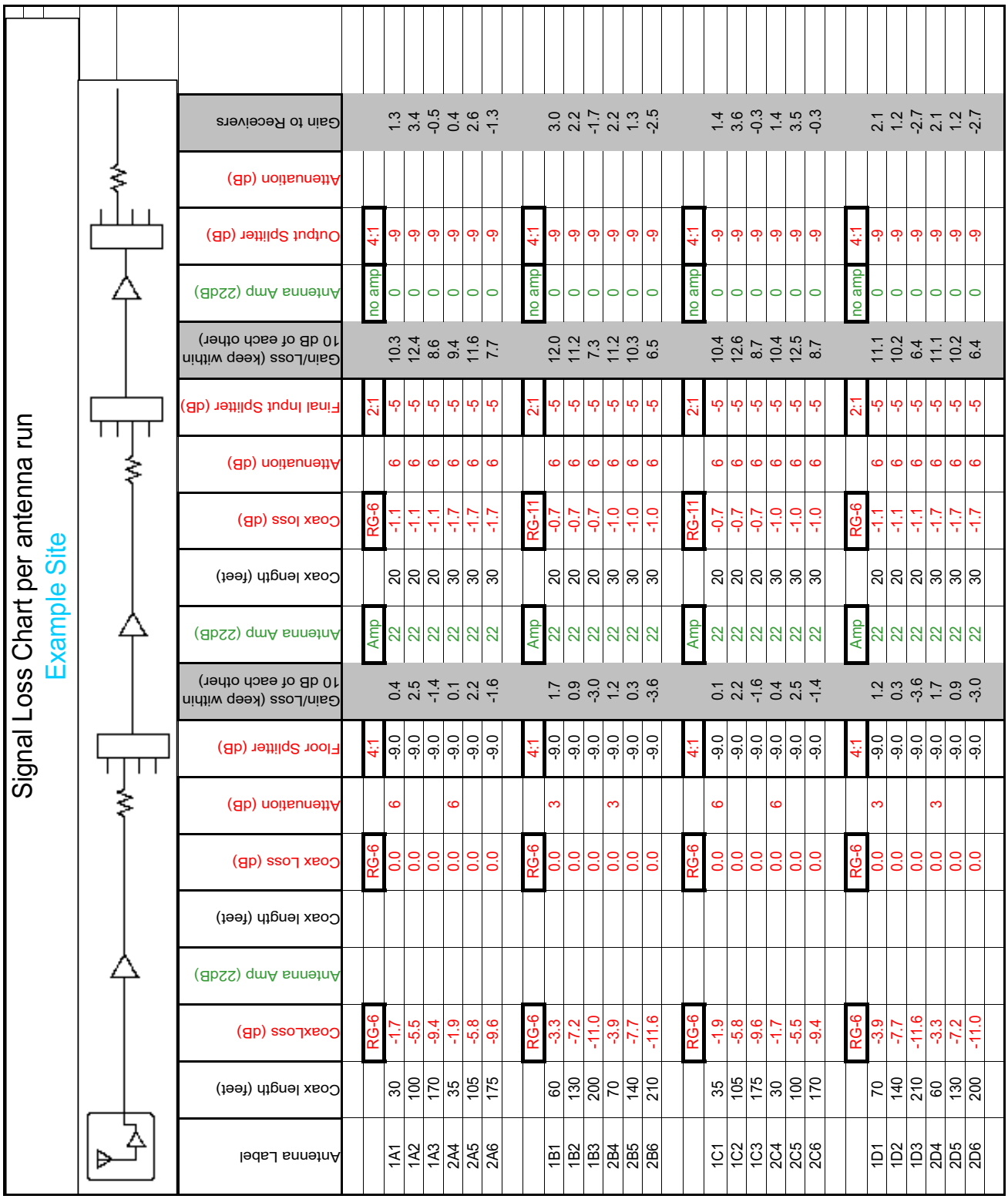
   The program calculates the dB loss and displays the value in the *Coax Loss* column.
6. Skip to the *Floor Splitter* column. Select the floor splitter by right-clicking in the *4:1* cell, then *Pick from List*.

7. Evaluate the first shaded *Gain/Loss* column. Add antenna amplifiers in the *Antenna Amp* column or attenuators in the *Attenuation* column until the values in *Gain/Loss* column are within 10dB of each other per field and not less than 0.
   - *Antenna Amp* – enter 22 if amplification is needed to balance this antenna run. (The antenna amplifier gain is 22dB.)
   - *Attenuation* – enter 0, 3, 6, 10, 20 or combinations of each if attenuation is needed to balance this antenna run.

   NOTE: Keep the values in this column (each field) within 10dB of each other.
8. If the *Coax Loss* calculation in step 5 is greater than 17dB, then split the cable halfway and insert an antenna amplifier. (Use *Antenna Amp* and *Coax Length* columns.) Enter the distance from the antenna amplifier to the floor splitter in the *Coax Loss* column.
9. Select the coaxial cable type by right-clicking in the *RG-6* cell, then *Pick from List*.
10. Enter the coaxial cable length (in feet) from the floor splitter to the final input splitter in the *Coax length* column.
11. Select the coaxial cable type used between splitters, by right-clicking in the *RG-6* cell, then *Pick from List*.
12. Select the *Final Input Splitter* by right-clicking in the *4:1* cell, then *Pick from List*.
13. Evaluate the second *Gain/Loss* column. Add antenna amplifiers in the *Antenna Amp* column or attenuators in the *Attenuation* column until the values in the *Gain/Loss* column are within 10dB of each other.
   - *Antenna Amp* – right-click the *Amp/no amp* cell and select *Amp* to enter 22 if amplification is needed to balance this antenna run. (The antenna amplifier gain is 22dB.)
   - *Attenuation* – enter 0, 3, 6, 10, 20 or combinations of each if attenuation is needed to balance this antenna run. Adding attenuation here attenuates the entire field.

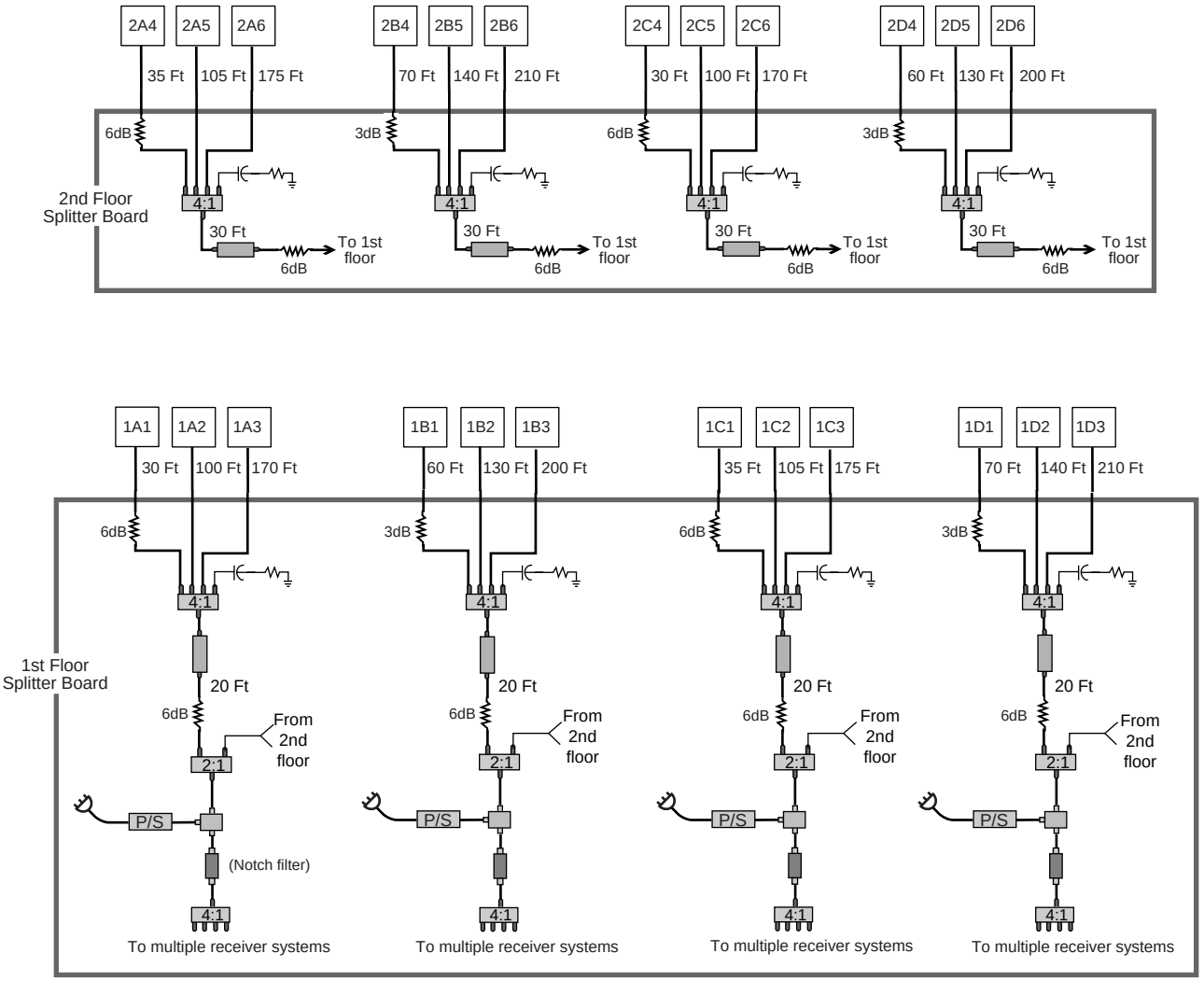
   NOTE: Keep the values in this column (each field) within 10dB of each other.
14. If connecting to more than one receiver system, select the *Output Splitter*. Select *None* for only one receiver system.
15. Evaluate the *Gain to Receivers* column. Add antenna amplifiers in the *Antenna Amp* column or attenuators in the *Attenuation* column until the value in the *Gain/Loss* column is between 0dB and +10dB.
16. Repeat the above steps in the Signal Loss Chart for each antenna.
17. After completing the Signal Loss Chart, add all attenuators and antenna amplifiers to the logical antenna schematic to balance the signals within 10dB of each other as shown following the Signal Loss Chart.

The sample Signal Loss Chart shown below represents the antenna logical schematic on page 3-25 and the multiple floor design on page 3-20 with added attenuators and amplifiers.

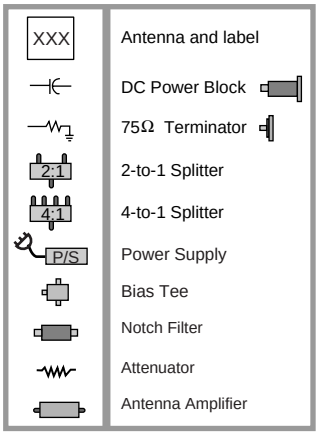


Antenna Label	Coax length (feet)	CoaxLoss (dB)	Antenna Amp (22dB)	Coax length (feet)	Coax Loss (dB)	Attenuation (dB)	Floor Splitter (dB)	Gain/Loss (keep within 10 dB of each other)	Antenna Amp (22dB)	Coax length (feet)	Coax loss (dB)	Attenuation (dB)	Final Input Splitter (dB)	Gain/Loss (keep within 10 dB of each other)	Antenna Amp (22dB)	Output Splitter (dB)	Attenuation (dB)	Gain to Receivers
		RG-6			RG-6	6	4:1	0.4	Amp	20	RG-6	6	2:1	10.3	no amp	4:1		1.3
1A1	30	-1.7			0.0		-9.0	2.5	22	20	-1.1	6	-5	12.4	0	-9		3.4
1A2	100	-5.5			0.0		-9.0	-1.4	22	20	-1.1	6	-5	8.6	0	-9		-0.5
1A3	170	-9.4			0.0		-9.0	0.1	22	30	-1.7	6	-5	9.4	0	-9		0.4
2A4	35	-1.9			0.0	6	-9.0	2.2	22	30	-1.7	6	-5	11.6	0	-9		2.6
2A5	105	-5.8			0.0		-9.0	-1.6	22	30	-1.7	6	-5	7.7	0	-9		-1.3
2A6	175	-9.6			0.0		-9.0											
		RG-6			RG-6	3	4:1	1.7	Amp	20	RG-11	6	2:1	12.0	no amp	4:1		3.0
1B1	60	-3.3			0.0		-9.0	0.9	22	20	-0.7	6	-5	11.2	0	-9		2.2
1B2	130	-7.2			0.0		-9.0	-3.0	22	20	-0.7	6	-5	7.3	0	-9		-1.7
1B3	200	-11.0			0.0	3	-9.0	1.2	22	30	-1.0	6	-5	11.2	0	-9		2.2
2B4	70	-3.9			0.0		-9.0	0.3	22	30	-1.0	6	-5	10.3	0	-9		1.3
2B5	140	-7.7			0.0		-9.0	-3.6	22	30	-1.0	6	-5	6.5	0	-9		-2.5
2B6	210	-11.6			0.0		-9.0											
		RG-6			RG-6	6	4:1	0.1	Amp	20	RG-11	6	2:1	10.4	no amp	4:1		1.4
1C1	35	-1.9			0.0		-9.0	2.2	22	20	-0.7	6	-5	12.6	0	-9		3.6
1C2	105	-5.8			0.0		-9.0	-1.6	22	20	-0.7	6	-5	8.7	0	-9		-0.3
1C3	175	-9.6			0.0		-9.0	0.4	22	30	-1.0	6	-5	10.4	0	-9		1.4
2C4	30	-1.7			0.0	6	-9.0	2.5	22	30	-1.0	6	-5	12.5	0	-9		3.5
2C5	100	-5.5			0.0		-9.0	-1.4	22	30	-1.0	6	-5	8.7	0	-9		-0.3
2C6	170	-9.4			0.0		-9.0											
		RG-6			RG-6	3	4:1	1.2	Amp	20	RG-6	6	2:1	11.1	no amp	4:1		2.1
1D1	70	-3.9			0.0		-9.0	0.3	22	20	-1.1	6	-5	10.2	0	-9		1.2
1D2	140	-7.7			0.0		-9.0	-3.6	22	20	-1.1	6	-5	6.4	0	-9		-2.7
1D3	210	-11.6			0.0		-9.0	1.7	22	20	-1.1	6	-5	11.1	0	-9		2.1
2D4	60	-3.3			0.0	3	-9.0	0.9	22	30	-1.7	6	-5	10.2	0	-9		1.2
2D5	130	-7.2			0.0		-9.0	-3.0	22	30	-1.7	6	-5	6.4	0	-9		-2.7
2D6	200	-11.0			0.0		-9.0											

The antenna logical schematic shown below is updated to show how the antenna system should be installed.



Note: DC block and terminate all unused F-connectors.



Create a Bill of Materials

Now that the logical antenna schematic is complete with antenna amplifiers and attenuators, you can create a bill of materials. Keep in mind that the schematic does not include the following:

- notch filters
- power supplies
- bias tees
- power cords
- hinge kit for rack mounting the receiver system

See chapter 7, Parts Lists and Drawings for ordering information and part numbers.

Calculate Voltage Drop

Calculate the DC voltage drop for the longest antenna run and the antenna run with the most amplifiers on it. Both the antenna amplifier and the antenna operate on as little as +8Vdc.

1. Determine the current draw for each section of the antenna run. The type of amplifier you use determines the amount of current required for that specific section. Refer to the table below.

Component	Current
Antenna	55 mA
Antenna Amplifier	40 mA

2. Use the table below to determine the DC resistance of the cable.

Coaxial Type	Ohms/1000 Ft	Ohms/Ft
RG-6 Riser	30	0.030
RG-6 Plenum	30	0.030
RG-11 Riser	13	0.013
RG-11 Plenum	13	0.013

3. Multiply the amplifier current and cable resistance to calculate the voltage drop on each section of the antenna run.

   (current draw) x (cable resistance) x (feet per section) = voltage drop

4. Add the voltage drops together for each antenna run. If the total voltage drop for any run is more than 3.5V, redesign the antenna run using different cabling or less cable length.
5. Perform the above steps for the longest antenna run and the antenna run with the most amplifiers.

Completion and Documentation of Site Survey and System Design

When the site survey is complete, submit copies of the following to Monitoring Technical Support and to the customer's installation project manager.

- Scaled drawings showing:
  - antenna location
  - area of coverage
  - splitter location
  - receiver system location
  - central station equipment location
  - cable feed-throughs (if multiple floor coverage)
  - other installation markings
- Logical antenna schematic design
- Signal loss chart
- Bill of materials
- List of all installation process details including the:
  - date that antenna parts must be onsite
  - date other equipment must be onsite
  - go-live date
  - names, phone numbers, and E-mail addresses of contact people
  - sales order number
  - action items and people responsible from the roundtable meeting.

For your notes

4 Installation

For your notes

Overview

The following is a summary of the installation specialist's responsibilities for installation.

- install coaxial cable.
- verify that power is installed as needed.
- terminate cables and test continuity.
- install antennas, amplifiers, power supplies, and bias tees.
- divide antenna fields to support all ApexPro Receiver Systems.
- tune antenna system
- verify that all antennas function.
- scan for noise and document noise.
- program TTX numbers to clean frequencies, then document and label. (See ApexPro Telemetry Transmitter service manual.)
- enter TTX numbers into the Clinical Information Center (CIC).
- perform a walk-through of the entire coverage area.

Install the antenna system using the antenna layout on the scaled drawings and the antenna logical schematic. This provides a close estimate on signal gains and losses. If necessary, adjustments can be made in the Test Antenna Components Functionality section.

After successful installation, the installation specialist forwards copies of the survey to Monitoring Technical Support, the local field engineer, and the hospital's biomedical department for future support and reference.

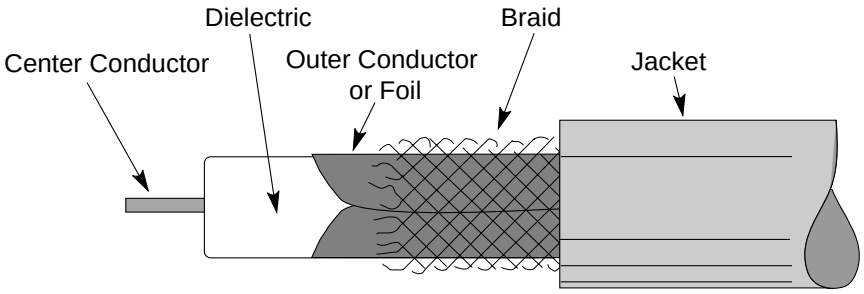
Install Coaxial Cable

Use the hospital scaled prints and the logical antenna schematic to install the cabling. Keep the following in mind when installing coax cable.

- Always follow the National Electric Code regulations.
- Always use PVC for the feed-throughs.
- Do not kink the cable. If the cable is kinked, cut out the kinked part and reattach.
- Do not pull cable over any metal edges or other abrasive surfaces.
- Do not pull cable for one room at a time. The entire cable spool should be accessible and multiple runs should be pulled at the same time into the ceiling.
- Do not lay cable on top of light fixtures.
- Lay out cable uniformly and with excess slack. The slack should consist of about one foot (25 cm) or so every 10 feet (3 m), both horizontally and vertically.
- Do not coil up any extra cable, but instead increase the amount of excess slack throughout the entire length of cable.

Coaxial Cable Preparation

These sections describe how to strip coaxial cable and crimp connectors to the cable. Below are descriptions of the components of a coaxial cable.

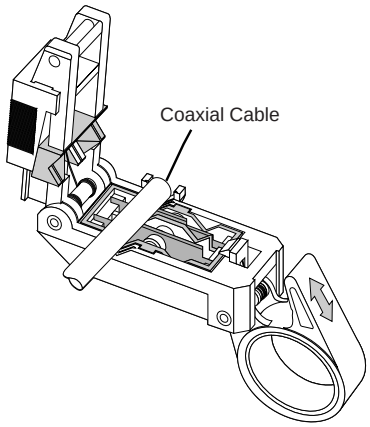


Center Conductor	The center conductor is the center-most feature of coaxial cable. It consists of solid copper or copper-clad aluminum wire.
Dielectric	The dielectric is an electrical insulation utilized to maintain position of the center conductor. It is composed of polyethylene in either solid or foam state. This insulator/positioner may also be evenly spaced solid polyethylene discs.
Outer Conductor or Foil	The outer conductor is either solid aluminum tube or an aluminum foil wrap. The cable size is usually derived from its outside diameter.
Braid	The braid is interwoven strands of aluminum or copper mesh. It extends the conductivity of the outer conductor to the sleeve of the connector.
Jacket	The black polyethylene coating over the aluminum outer conductor protects it from scratches or abrasions during handling and provides a weather-tight seal. The jacket on plenum cable is made of teflon specified by fire codes.

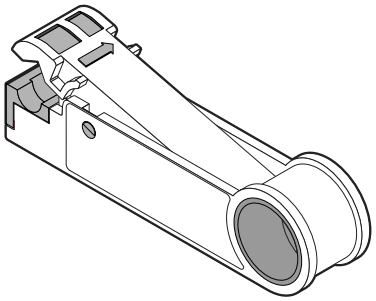
Strippers and Crimpers

The following paragraphs describe how to correctly strip coaxial cable. RG-6 is the recommended coaxial cable, but RG-11 cabling is used for some installations. The following are the recommended cable strippers and crimpers.

- Use Xcelite coaxial cable stripper (3 CSK-GN) for RG-6 coax cable.



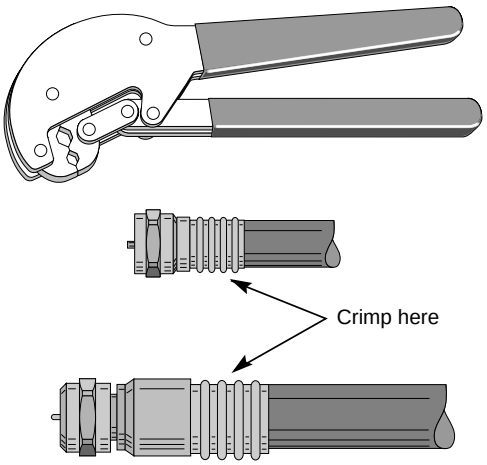
- Use Cable Prep cable stripper, CPT-1100, for RG-11 coax cable.



The typical hex crimping tool is shown below. The recommended crimping tool part numbers are the following.

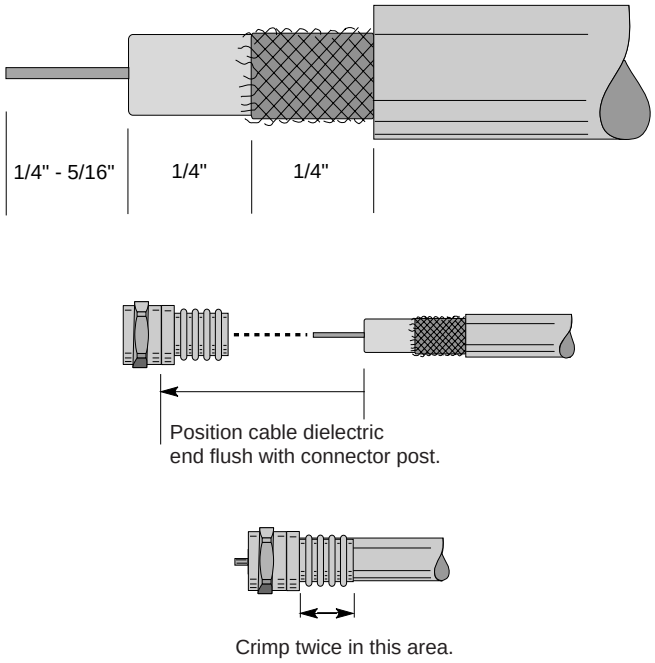
- Use a G-CRT-659 from Gilbert or HCT-659 crimper from Cable Prep for riser RG-6.
- Use a HCT-986 crimper from Cable Prep for plenum RG-6.
- Use a G-CRT-211 from Gilbert or HCT-211 crimper from Cable Prep for riser and plenum RG-11.

Before you crimp, check the dimensions for the different types of coaxial cable and connectors.



RG-6 Cable Preparation

Recommended stripping dimensions for RG-6 riser or plenum cabling are shown below.



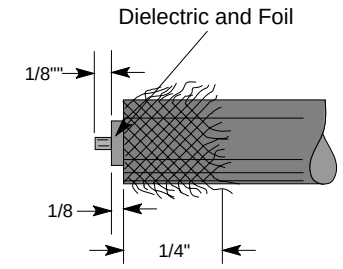
The stripper requires 3 blades spaced 0.25 inch apart. The crimp tool jaw dimension is 0.324 inch.

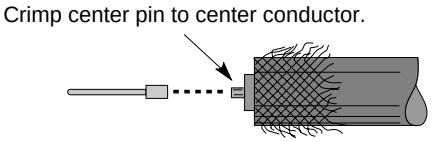
1. Open the stripper and place the cable so that 1/4 – 5/16 inch of cable extends past the first blade.
2. Close and latch the stripper and rotate around the cable 3 – 4 times.
3. Open the stripper and adjust stripping blades until the correct dimensions are achieved as shown in the figure above.
   - Expose the center conductor 1/4 – 5/16 inch. Do not score the conductor.
   - Expose the dielectric 1/4 inch without braid.
   - Expose the braid 1/4 inch. Do not score the braid or fold it back over the jacket.
4. Place the connector over the prepared cable. Make sure the braid does not fold back over the jacket.

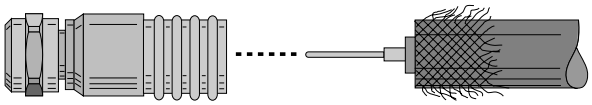
   The connector is properly positioned when the cable dielectric end is flush with the connector post end. (See figure above.)
5. Crimp the connector in two places. (This is necessary due to the connector sleeve width.) The crimps may overlap and the resulting hex flats should align.

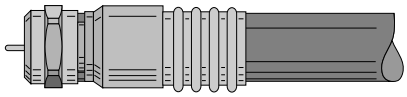
RG-11 Cable Preparation

Recommended stripping dimensions for the RG-11 riser or plenum cabling are shown below.









For RG-11 coaxial cable, use stripper CPT-1100.

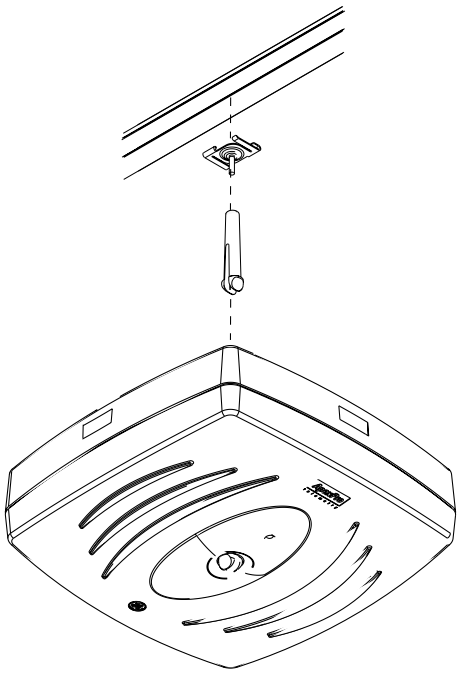
1. Hold the stripper open and insert the coax cable into the groove position. Align the clean cut edge of the coaxial cable with the outside edge of the stripper.
2. Close the stripper.
3. Rotate the stripper around the coaxial cable *at least* 5 times.
4. Pull the cable out carefully while squeezing the stripper.

Install Antennas

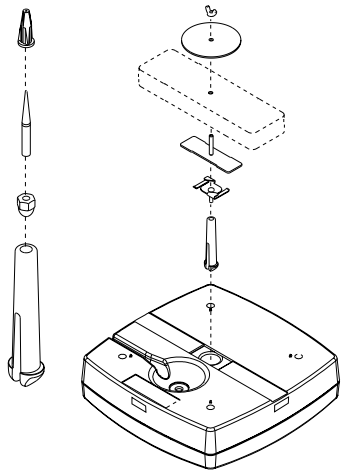
NOTE: Be sure that after planning and designing the antenna system, the Penetration Check (chapter 3, Site Survey and Antenna System Design) is completed. It is used to estimate the RF penetration of the hospital construction.

The standard installation for antennas uses a T-bar mount connected to the drop ceiling support. The retaining clip and pin come with the antenna.

For ceiling tile or dry wall mounting, see chapter 7, Parts Lists and Drawings to order additional hardware kits necessary for these mounting options. All antenna mounting installation options and instructions are described in the ApexPro Telemetry Receiver Antenna System mounting instructions that are included with the antenna.



Standard installation



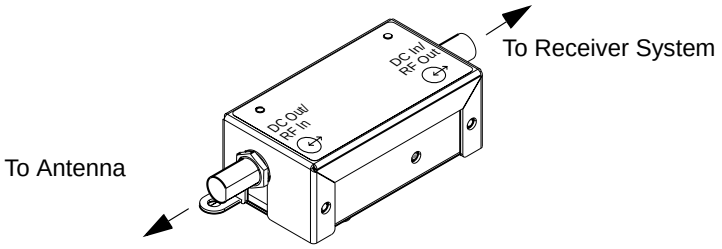
Optional dry wall mount and ceiling tile mount

For customer site reasons, some antennas may require installation above the ceiling. Keep the following in mind when installing antennas above the ceiling:

- Do not distribute the antennas haphazardly above the ceiling. Custom mounting procedures are needed.
- Mount antennas level and horizontal to the ceiling for best performance.

Install Antenna Amplifiers

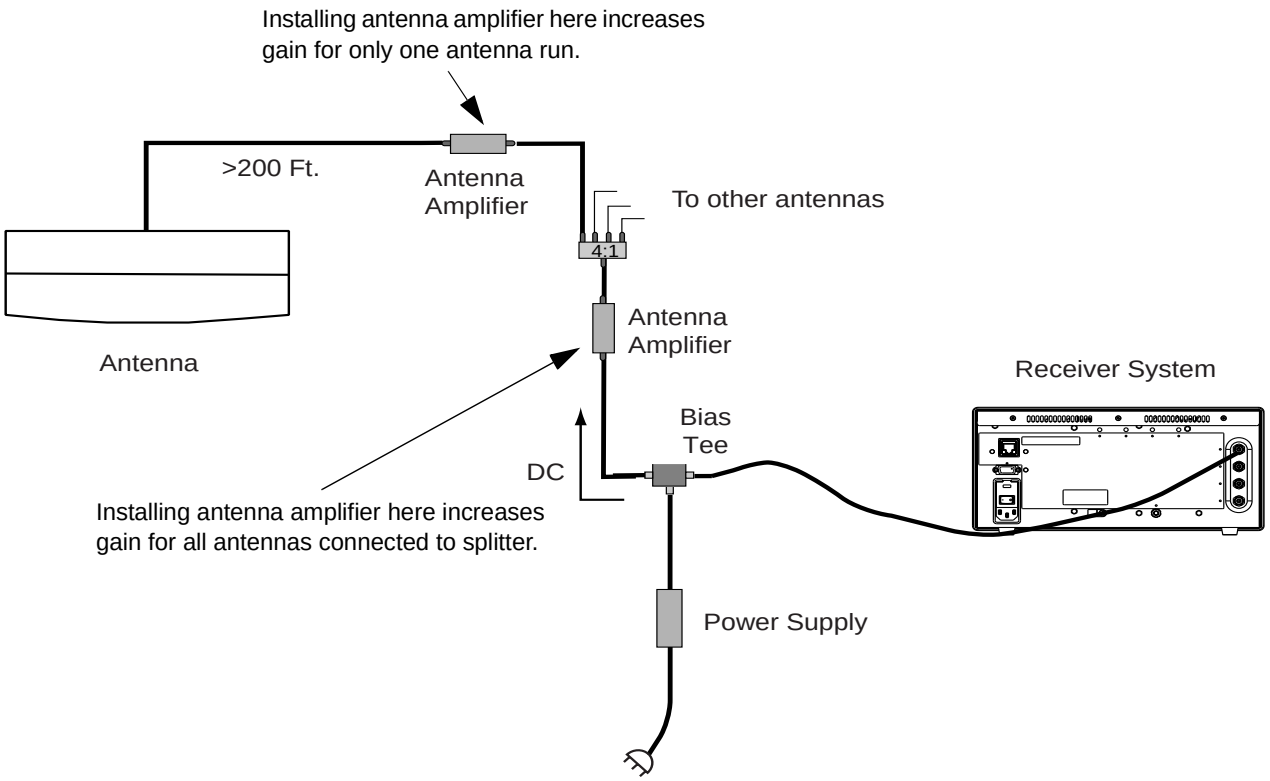
Install an antenna amplifier when the gain of the signal from the antenna drops below unity gain.



Connection orientation

Do not install antenna amplifiers next to each other or near an antenna. This may cause the amplifier to saturate due to the gain of the first amplifier and cause noise spikes seen at the Receiver System. Because there is no DC present between the bias tee and the Receiver System, do not install the antenna amplifier in this location.

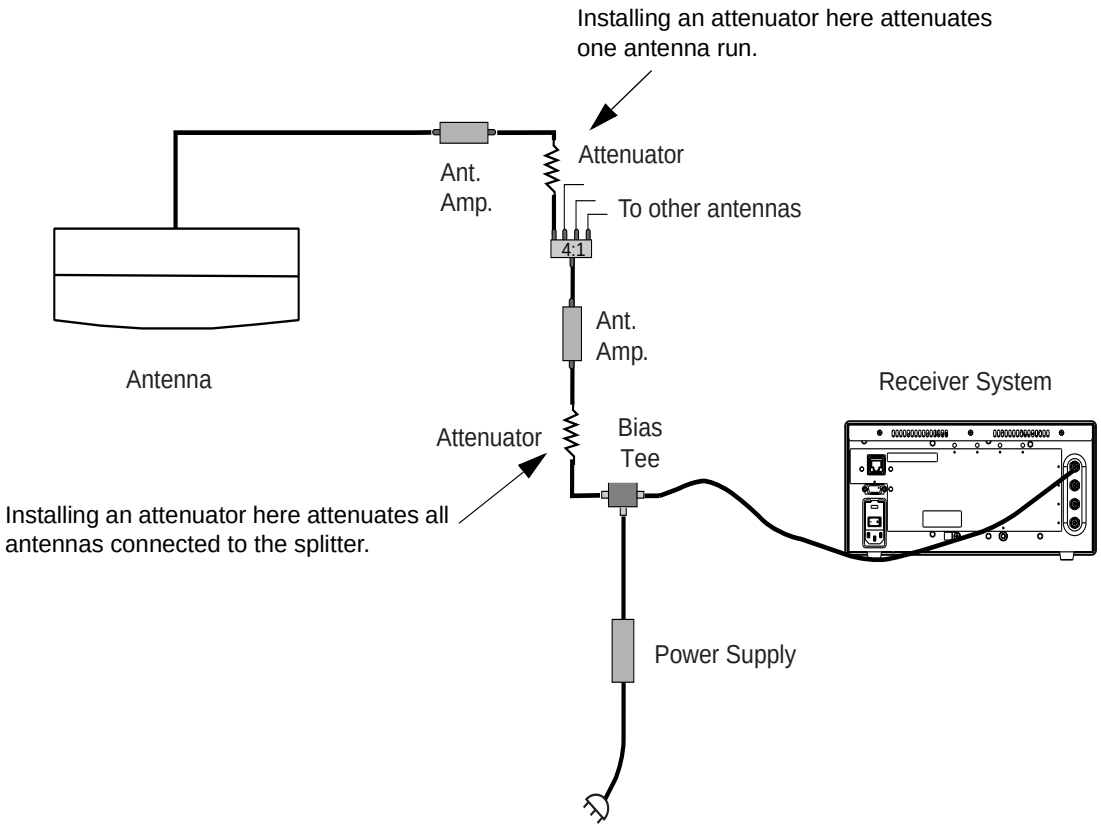
Use Signal Loss Chart program as a guide to locate antenna amplifiers in system.



Install Attenuators

Attenuators balance antenna runs before combining runs into antenna fields. Attenuators also lower signal levels before they enter the Receiver System to a transmitter signal level below –30dBm. If the transmitter signal level is –30dBm before the input to the ApexPro Receiver System, either attenuate before the input of the system or remove the amplifier from the antenna run. Attenuators also balance antenna runs of an antenna field. This keeps the signal levels within 10dB of each other.

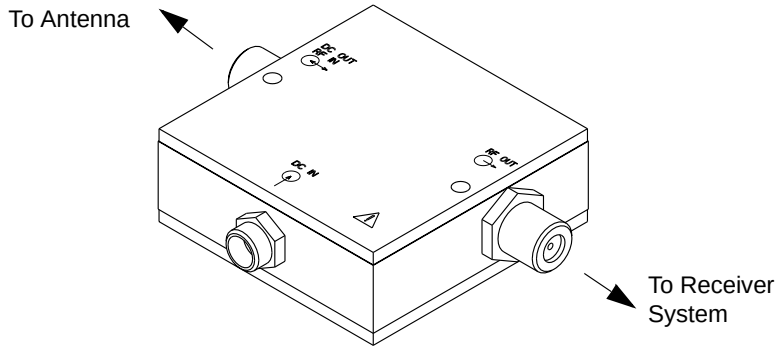
In most cases the attenuators are located near the antenna splitters (combiners). Do not place attenuators near the antenna. Use the Signal Loss Chart program as a guide to locate attenuators in system.



Install Power Supplies and Bias Tees

Power supplies and bias tees are usually installed on the splitter board. If the Receiver System and CIC are installed with emergency power, then typically the antenna power supplies are also installed on emergency power.

One power supply minimum per antenna field with a maximum of 18 antennas/antenna amplifiers per power supply. If there are more than 18 antennas/antenna amplifiers per field, then segment the antenna field and divide the load of the antenna/antenna amplifiers to another power supply and bias tee.

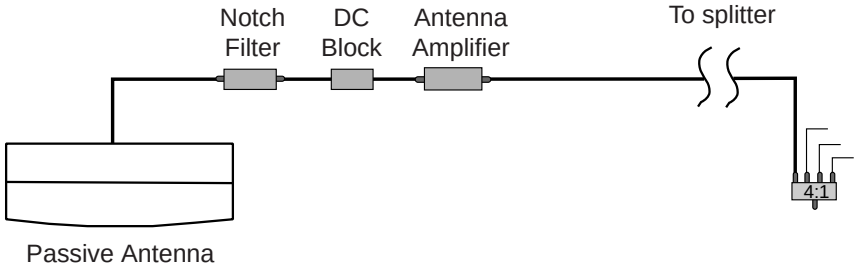


Connection orientation

Install Notch Filters

To protect the Receiver System, install each channel notch filter on the antenna fields as determined by the site survey. Multiple notch filters can be installed on a given antenna field. Install them between the bias tee **RF OUT** and the Receiver System. Do not install notch filters on the **DC OUT/RF IN** side of the bias tee because components may be damaged if DC is applied.

To protect the antenna amplifier, install each channel notch filter on the antenna run as determined by the site survey. Multiple notch filters can be installed on a given antenna run. Install them between the passive antenna and the DC block/antenna amplifier. Do not install notch filters without first using a DC block because components may be damaged if DC is applied.



Test Antenna Components Functionality

Equipment

The following equipment is needed to perform the functionality test.

- spectrum analyzer 20 – 900 MHz
- patient simulator
- two-way radio

Test

Use the following steps to ensure that each antenna amplifier and antenna in every antenna field is receiving the RF signal at a proper level.

NOTE: The following test requires two people and the layout scaled drawing of the antenna fields.

1. Check that the green LED illuminates on every antenna and antenna amplifier.
2. Connect a telemetry transmitter to the simulator using leadwires. Program the test transmitter frequency into the spectrum analyzer. Set the span to 250kHz, amplitude –30dBm.
3. Connect the spectrum analyzer to the back of the Receiver System at the **Antenna RF In** connector of the first field to test.
4. While holding the transmitter chest high, have one person stand to the side (within 5 ft.) of each antenna of the selected field and rotate the transmitter to receive its peak value.
5. The other person records each signal level on the scaled drawing for future comparison. The recommended transmitter reading is between -35 and -45dBm at each antenna. Noise floor should be below -100dBm.

   If you tuned your system using the spreadsheet, all signals between antennas and fields should look balanced.
6. If antenna fields show a much higher noise floor than expected, remove one antenna at a time until you find the noise antenna. Relocate the antenna if possible or eliminate the noise source.

NOTE: If the signal strength is above -30dBm, attenuate the signal at the spectrum analyzer and adjust the reading accordingly.

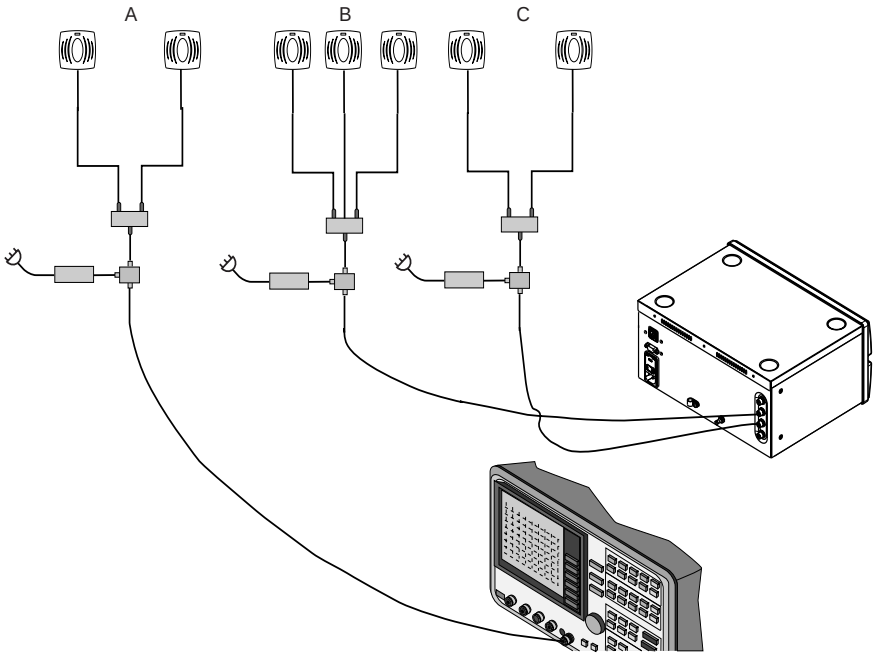
Some antenna runs require balancing with attenuators or antenna amplifiers depending on the recorded antenna signal levels.

Scan for Noise and Document

After completing the installation and checking the functionality of each antenna, search the RF spectrum for external noise from 560–614MHz (or 420–474MHz international) with a spectrum analyzer. Identify and document these noises on the TTX Frequency Chart in Appendix A (U.S. or international) so that the telemetry transmitters are not programmed to those frequencies. The TTX Frequency Chart is also available from Monitoring Technical Support. Call 800-558-7822 or go to the Monitoring Technical Support intranet site at

http://rssmast/monitoring/survey/mainsurveyhomepage.htm

1. Disconnect an antenna field from the Receiver System and connect it to the spectrum analyzer as shown below.



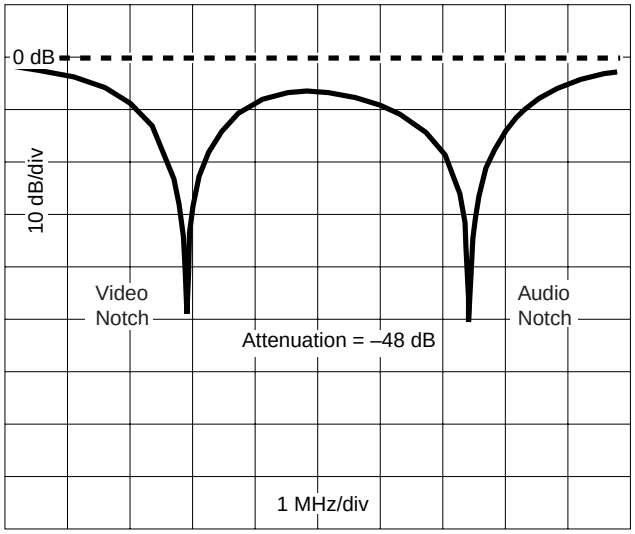
2. Scan the RF spectrum for external noise spikes and document the dB level in the TTX Frequency Chart.
3. Repeat steps 1 and 2 for the remaining antenna fields.
4. After identifying and documenting all noise spikes, the new transmitters can be programmed to the remaining “clean” frequencies.

Program Transmitters and Document TTX Numbers

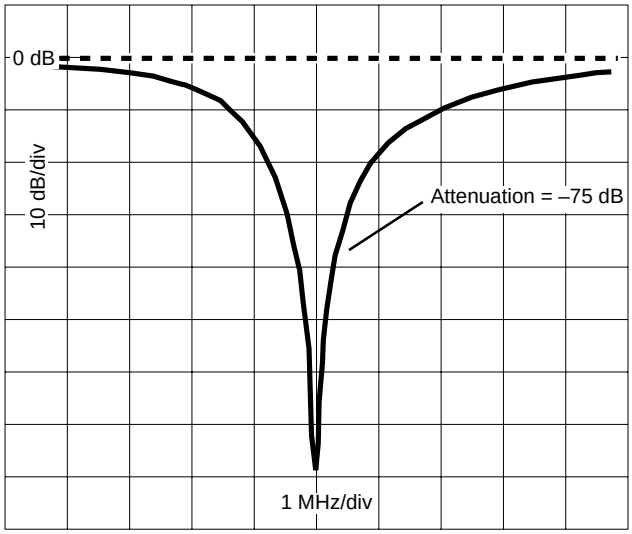
Notch Filter Guidelines

If notch filters are used with the antenna system to attenuate the local TV station(s), use these guidelines when programming the transmitters.

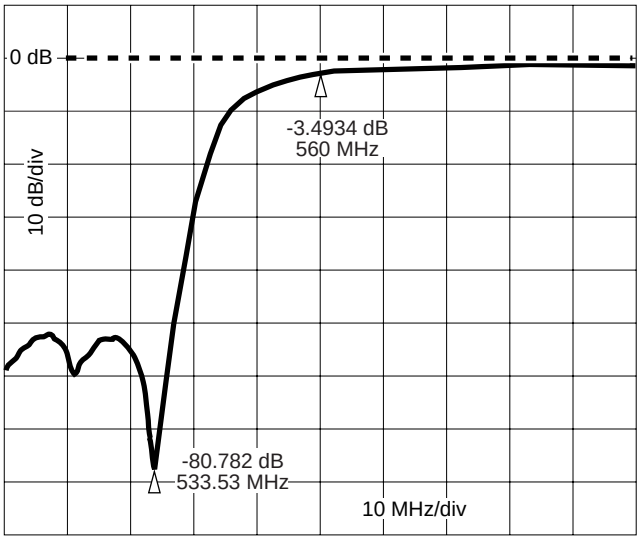
Do not have transmitters operating or programmed within 1.5MHz of either side of the video and/or audio notch filter.



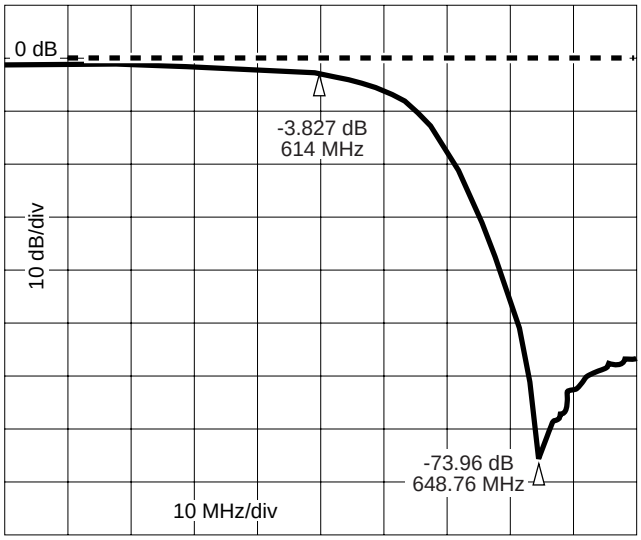
Notch Filter Channels 29 – 37



Notch Filter Channels 36 and 38



High Pass Filter Channel 29



Low Pass Filter Channel 37

The following table shows the effect of notch filters on TTX numbers.

Video/Audio Notch Filter Channel	Video Notch (MHz)	Audio Notch (MHz)	Frequency Range Effected	TTX Numbers Effected
26	543.25	547.75	541.75 - 549.25	none
27	549.25	553.75	547.75 - 555.25	none
28	555.25	559.75	553.75 - 561.25	6600 - 6650
29	561.25	565.75	559.75 - 567.25	6600 - 6890
30	567.25	571.75	565.75 - 573.25	6830 - 7130
31	573.25	577.75	571.75 - 579.25	7070 - 7370
32	579.25	583.75	577.25 - 585.25	7290 - 7610
33	585.25	589.75	583.25 - 591.25	7530 - 7850
34	591.25	595.75	589.75 - 597.25	7790 - 8090
35	597.25	601.75	595.75 - 603.25	8030 - 8330
36	603.25	607.75	601.75 - 609.25	8270 - 8570
36 Video	603.25	N/A	601.75 - 604.75	8270 - 8390
37	none	none	WMTS band	none
38 Center	Notch at 617.00MHz	none	none	none
39	621.25	625.75	619.75 - 627.25	none
40	627.25	631.75	625.75 - 633.25	none
41	633.25	637.75	631.75 - 639.25	none
Low Pass 614MHz	none	none	> 614MHz	none
High Pass 560MHz	none	none	< 560MHz	none

Program and Document

Transmitters are programmed using a laptop and a programming device. The programming kit, pn421733-001, comes with instructions.

If using channel 37 in the U.S. (Wireless Medical Telemetry Service 608–614MHz reserved band), contact the frequency coordinator for available frequencies in the channel 37 band before programming the transmitter.

1. Document the TTX numbers effected by the installed notch filter(s) on the TTX Frequency Chart in Appendix A so that no transmitters are programmed in that range. (See table on previous page.)
2. Program the transmitters to the available frequencies and document the serial number of the transmitter on the TTX Frequency Chart. Give a copy of the chart to the frequency coordinator for their database.
3. Enter the TTX numbers in the CIC. Refer to the Marquette Prism Information Server Service Manual for instructions.
4. Keep the TTX Frequency Chart on site for the site bio-med, frequency coordinator, local field engineer, and technical support to reference.

For your notes

5 Checkout Procedures

For your notes

Required Tools and Special Equipment

Below is a list of required tools and special equipment used for the checkout procedures in this chapter. You may substitute equivalent equipment.

Item	Part/Model Number
Telemetry Transmitter	APRO-US-ENG-AHA-1
Patient Simulator	MARQII
6-Leadwire Set, 5-Leadwire, AHA	Compatible
Spectrum Analyzer[1]	HP 8590 ESA-L1500A
DC Power Block	17102-001
BNC-to-F Adapter	1886-411
F-Type/F-Type Test Cable, 10-Ft	401904-001
2:1 Splitter	3504-102
2-way Radios[2]	

1. Refer to the Spectrum Analyzer Operator's Manual for proper setup.
2. Because 2-way radios may degrade the performance of the antenna system, only use them when necessary to communicate while testing antenna system coverage.

Overview

Check out the system after all the antennas, amplifiers, coaxial cable, and connectors are in place, the antenna system is calibrated and every antenna aligned. If the antenna was already functional but now exhibits problems, skip to the troubleshooting procedures in chapter 6, Troubleshooting.

After installation check out the system:

- Admit a test transmitter to the CIC.
- Perform a transmitter walk-through checking the CIC for signal dropout.
- Double check the position of all antennas, amplifiers, and any other added components with the scaled drawings. Record any variance you may observe on the scaled drawings.
- Use an ohm meter to test the antenna system for any short or open circuit.

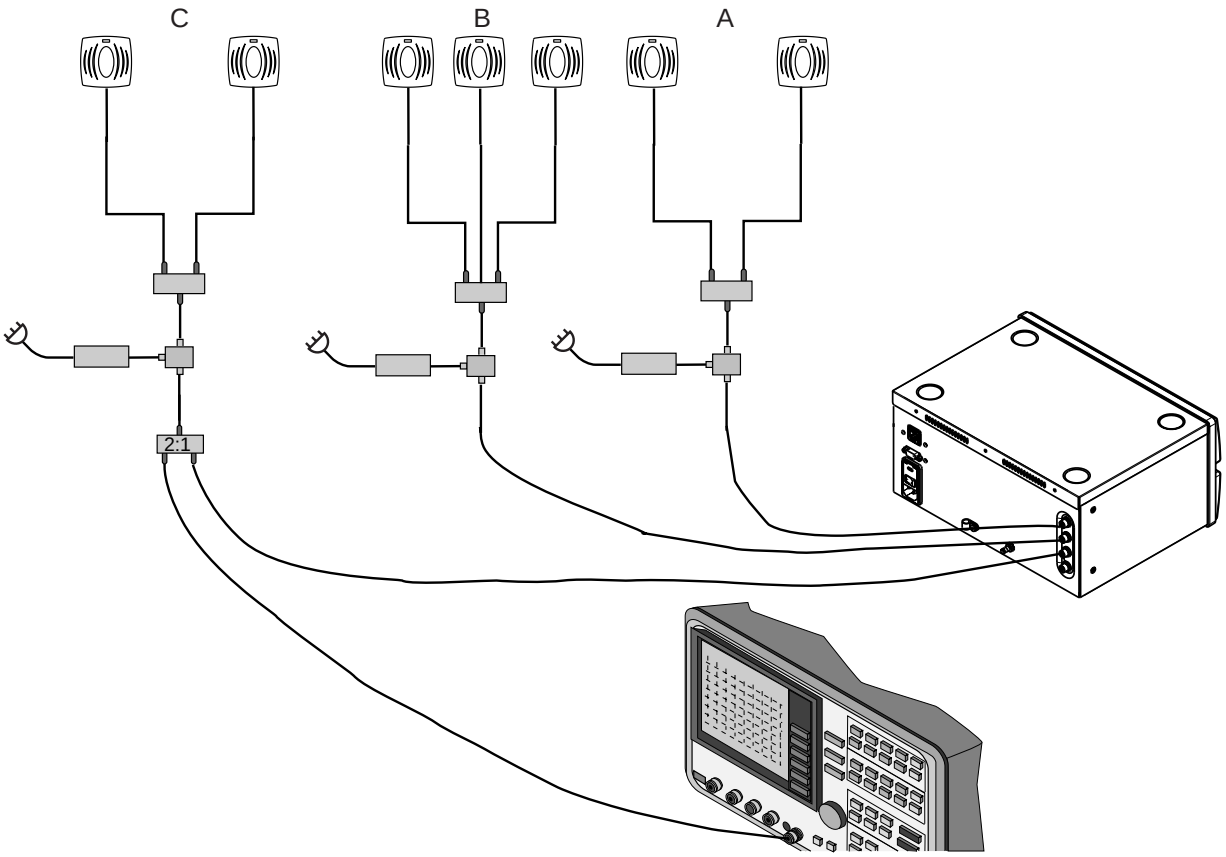
NOTE: For best results with every procedure, test the antenna system on a field by field basis. This diminishes the chance of omitting any run of the antenna system.

WARNING
Notify hospital personnel that patient monitoring may be interrupted before attempting any of the following procedures.

Check Antenna System Coverage

NOTE: The coverage check requires two people, the marked up scaled drawings of the antenna fields, and the logical antenna schematic.

1. Connect yourself or your test partner to a test telemetry transmitter.
2. Admit the test transmitter TTX to the central station.
3. At the CIC, click *Setup CIC*.
4. Click the *Service Password* tab.
5. Type password, **mms_com** and press **Enter**.
6. At the MS-DOS prompt, type **setflags -dup on** and press **Enter** to allow entering a duplicate TTX for 5 minutes.
7. Type **setflags -mark all** and press **Enter**.
8. Admit the same TTX as in step 2 to another available receiver.
9. Have your test partner hold the transmitter chest high and walk the entire coverage of the antenna system while you watch the central station for any dropout (yellow tick marks display). Have your test partner walk all patient areas such as bathrooms, entire patient bedrooms, hallways and lounge areas.
10. Record the location of any dropout.
11. If you detect RF signal dropout, determine if dropout is caused by poor coverage, antenna improperly tuned, or defective transmitter. (Refer to chapter 6, Troubleshooting.) Retest by repeating steps 9 and 10.
12. Have your test partner hold a transmitter in one place in the coverage area. Connect the spectrum analyzer to the connector of each antenna field and record the RF signal reading. (See figure on next page.)



13. Compare the four antenna field signal readings. At least two antenna fields should record a minimum of –80 dBm for normal operation.

    If the levels are too low, you may not have unity gain, or you have a coverage problem. More antennas may be required.

14. When you determine that the antenna coverage is sufficient, return to the CIC and click *Setup CIC -> Service Password*.
15. Type password, **mms_com** and press **Enter**.
16. Type **setflags -dup off** and press **Enter**.
17. Type **setflags -mark off** and press **Enter**.
18. Disconnect all test equipment.

6 Troubleshooting

For your notes

Required Tools and Special Equipment

This is a list of required tools and special equipment used in performing the troubleshooting procedures. You may substitute equivalent equipment.

Item	Part Number/Model
Telemetry Transmitter	APRO-US-ENG-AHA-1
Patient Simulator	MARQII
Patient Cable, 5-Leadwire, AHA	Compatible
Leadwire Set, 5-Leadwire, AHA	Compatible
Digital Multimeter (DMM)	Fluke 8060A
DC Power Block	17102-001
BNC-to-F Adapter	1886-411
2 F-Type/F-Type Test Cable, 1-Ft	405296-004
F-Type/F-Type Test Cable, 10-Ft	401904-001
2:1 Splitter	3504-102
Spectrum Analyzer[1]	HP 8590 ESA-L1500A

1. Refer to the Spectrum Analyzer Operator's Manual for proper setup.

Troubleshooting an Antenna System

Basic

The following procedure helps troubleshoot an antenna system that is experiencing problems.

1. Ask hospital personnel if transmitter dropout was:
   - found with only one transmitter or only one receiver,
   - found in only one coverage area,
   - during the same time of day, or
   - found in coverage of one antenna field.
2. Confirm all components of the system are correctly connected and turned on.
3. Inspect all cables and connections.
4. Ensure that the suspect antenna or antenna amplifier is plugged in correctly and the LED is on.
5. Swap suspect antenna or antenna amplifiers with known good ones.
6. Replace suspect attenuators or notch filters with known good ones.
7. Replace suspect splitters and connectors with known good ones.

Extended

The following is more extensive troubleshooting.

1. Perform the Measure the Antenna System Voltages procedure presented later in this chapter to determine if proper voltage is being delivered to the cable amplifier.

   If voltages under +8.0V are found, continue troubleshooting to determine where the voltages are adequate.
2. Record voltages at the furthest antenna and amplifier, and work back to the receiver system, one antenna at a time. Wherever the voltage is less than +8.0V, the antenna run is too long.
3. Try one of the following to raise the voltage to an acceptable level.
   - Shorten antenna runs that measure less than +8.0V.
   - Replace cabling with cabling that has less DC loss.
   - Install an additional power supply closer to the farthest antenna.
4. Perform the Test Antenna Components Functionality procedure in chapter 4, Installation, to determine signal strength.
5. Perform the Check Antenna System Coverage procedure in chapter 5, Checkout Procedures, to ensure coverage.
6. Perform the Troubleshooting ECG Dropout procedure later in this chapter to determine the source of dropout and to balance the antenna field with attenuators.

Troubleshooting ECG Dropout

WARNING
Notify hospital personnel that patient monitoring may be interrupted before attempting any of the following procedures.

These troubleshooting procedures are recommended for an antenna system experiencing dropout. ECG dropout can be caused from the network or from RF problems.

Verify that dropout is not an intermittent lead fail condition by viewing all leads of the suspect signal. If any one lead is not dropping out, the problem is lead fail and not RF dropout.

TTX Dropout Diagnostics

Enable the TTX dropout diagnostics command at the CIC to view signals indicating dropout.

1. At the CIC, click *Setup CIC*.
2. Click the *Service Password* tab.
3. Type password, **mms_com** and press **Enter**.
4. At the MS-DOS prompt, type **setflags -mark ttx** and press **Enter**.

This displays color diagnostic tic marks at the bottom of each window indicating the reason for missing waveform data. Listed below are the colors and their indication.

Color	Indication
Yellow	Missing data from the transmitter
Dark Green	Missing data from the receiver
Magenta	Missing data from the receiver system
Orange	Missing data from the hardware manager
Light Gray	A lead fail is occurring

The following sections cover causes and solutions for waveforms displaying the yellow tic marks (missing data from the transmitter).

External Noise

External RF signals may need to be notched if the signal strength exceeds –50dBm on any given field. Notch filter frequencies are identified in chapter 3, Site Survey and Antenna System Design. If a notch filter is not available for the specific frequency, then attenuate the antenna field to lower the signal strength. This may cause poor telemetry transmitter signal reception, thus requiring more antennas to increase coverage.

- Receiver international frequency range 420 – 474MHz
- Receiver U.S. frequency range 560 – 614MHz

TTX Noise

Check the transmitter to find out if the noise source exists for that frequency.

1. Enter the frequency of the suspect transmitter in the spectrum analyzer.
2. Remove the transmitter batteries temporarily to see if the noise source exists for the given frequency. Do not use a signal stronger than 3dB over the noise floor.
3. Eliminate the noise source, if possible, or reprogram the transmitter to an available 'clean' frequency.
4. Inform the frequency coordinator of any TTX number and frequency change and also log it on the TTX Frequency Chart.

High Noise Floor on an Antenna Field

If one antenna field has a high noise floor compared to the other antenna fields, either the antenna is not tuned to unity gain, or the antenna is near a noise source. Follow these steps to resolve the problem.

1. Remove one antenna at a time at the splitter location until the noise floor drops to an acceptable level.

   Keep the noise floor as low as possible. The noise floor for all antenna fields should not be above –100dB.
2. When you find the faulty antenna field, recalculate the antenna run for signal gains and losses using the Signal Loss Chart in chapter 3, Site Survey and Antenna System Design. Tune the antenna as instructed in the Test Antenna Components Functionality section of chapter 4, Installation.
3. Move the antenna from any noise source like electric motors or fluorescent lights. Antennas should be installed at least 1/2 meter from fluorescent lights.

Low Transmitter Signal at the Receiver

Signals must maintain a 20dB signal-to-noise ratio for any two antenna fields. A low transmitter signal at the receiver may be caused by an antenna system not tuned for unity gain or a transmitter signal unable to penetrate construction materials.

Retune the antenna system for signal gains and losses using the Signal Loss Chart in chapter 3, Site Survey and Antenna System Design.

If the transmitter signal is low, antennas may need to be relocated into patient rooms or additional antennas installed for better coverage.

Defective Antenna or Components

Follow these steps to check for a defective antenna or antenna components.

1. Verify that the green LED on the antenna is illuminated. If it is not, the antenna is not getting power or it is defective.

   Many antenna components have a 1A current rating. Follow the power supply design in chapter 3, Site Survey and Antenna System Design to stay within current limits. The antenna and antenna amplifier will not perform below 8.0Vdc.

2. Block and terminate all unused F-connectors on the splitters. If all four antenna fields on the receiver system are not used, then terminate the unused fields.
3. There are four active components in the antenna system; the antenna, antenna amplifier, bias tee, and power supply. Interchange these components among fields to troubleshoot a bad component.
4. Make sure all antenna components are installed properly. Check the component label if in doubt.
5. Follow the coaxial cable crimping guidelines in chapter 4, Installation. Carelessly terminating the cable can lead to shorts or opens.
   - Do not let the grounding braid wrap around the center conductor when stripping the cable.
   - Make sure the center conductor extrudes just past the end of the connector when crimping on the connectors.

Defective Receiver System Components

Refer to the ApexPro Receiver System Service Manual if you suspect the quad receiver module or the receiver system PCB (backplane).

Measure Antenna Voltage

Perform the following steps with the antenna field under full load. All amplifiers and associated antenna components (attenuators, splitter, etc.) must be connected. Check the voltage for one antenna field as follows.

WARNING
Shock hazard. Be aware of 12Vdc present at all **DC IN** bias tee connectors.

1. Go to the furthest antenna and amplifier from the receiver system.
2. Disconnect the antenna field from the **DC In/RF Out** connector of the amplifier and measure the voltage on the coaxial cable from the center conductor to the outer shield.
3. Verify a minimum of +8.0V referenced to chassis ground. If it is not, record voltage.
4. If the voltage reading is low, make the antenna run shorter, or move the power supply and bias tee closer to the antenna.
5. Disconnect the test cables and reconnect the coaxial cable to the antenna.
6. Repeat the above steps for the furthest antenna and amplifier connected to each field.

7 Parts Lists and Drawings

For your notes

Antennas

ApexPro Antenna 560–614MHz

The ApexPro antenna can handle RF signals up to –17dBm within the ranges of 560–614MHz. It can operate down to +6Vdc and draws 40mA of current.

Identify the antenna by its part number label and the GE label on the front (bottom).

ApexPro Antenna Hi Pwr 420–474MHz or 560–614MHz

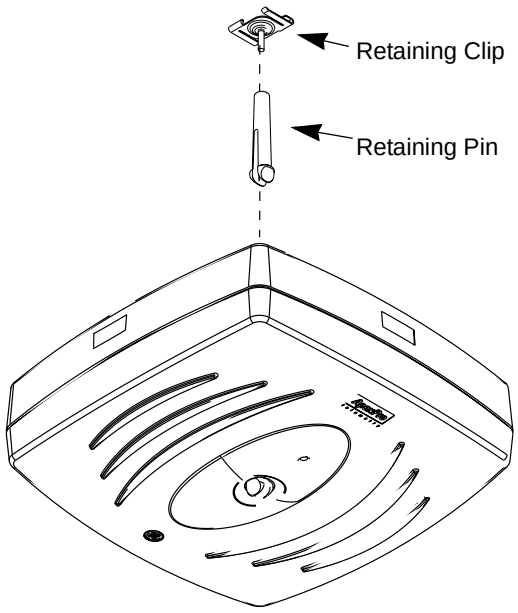
The high power antenna can handle RF signals up to –15dBm within 420–474MHz or 560–614MHz and has more filtering for out-of-band signals. It can operate down to +8 Vdc, draws 55mA of current, and has >15dB rejection below 470MHz (320MHz for -004 antenna).

Identify the high power antenna by its part number label and the GE logo only on the front (bottom).

ApexPro Antenna Passive

The passive antenna has no internal filtering or amplification, therefore requires no dc voltage. Use this antenna with notch filters or high/low pass filters and an in-line amplifier. Use only when the other antennas do not meet design requirements.

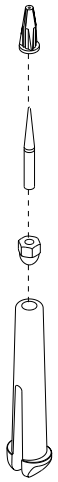
The passive antenna looks identical to the high power antenna except it has a black cap over the LED power indicator.



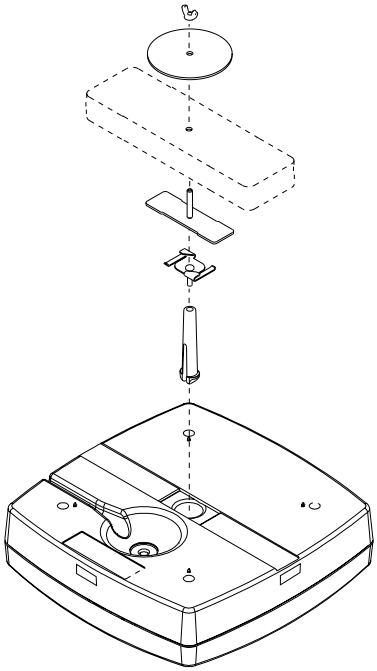
ApexPro Antenna

Description	Part Number
ApexPro Antenna (560-614MHz)	2000673-001
ApexPro Hi Pwr Antenna (560-614MHz)	2000673-002
ApexPro Passive Antenna (560-614MHz)	2000673-003
ApexPro Hi Pwr Antenna (420-474MHz)	2000673-004
ApexPro Passive Antenna (420-474MHz)	2000673-005
The above antennas come with the following mounting hardware: Retaining Pin Ceiling Retaining Clip	 419524-001 45153-007
Antenna Labels	2001522-001

Antenna Specifications			
Performance Specifications			
Type	**-001**	**Hi-Pwr -002 and -004**	**Passive -003 and -005**
Voltage range	6.0 – 15.0V	8.0 – 15.0V	N/A
Minimum voltage	6.0V	8.0V	N/A
Current draw	40mA	55mA	N/A
Gain	17dB	17dB	–5
Operating Conditions			
Ambient temperature	10°C to 35°C (50°F to 95°F)		
Relative humidity	25% to 85% (non condensing)		
Storage Conditions			
Temperature	–40°C to 70°C (–40°F to 158°F)		
Relative humidity	15% to 95% (non condensing)		
Pressure	500 hPa to 1060 hPa		
Warranty			
Standard warranty is one year. Other options are available.			
Dimensions			
11 in. x 11 in. x 3.5 in.			



Optional Drywall Mount Hardware

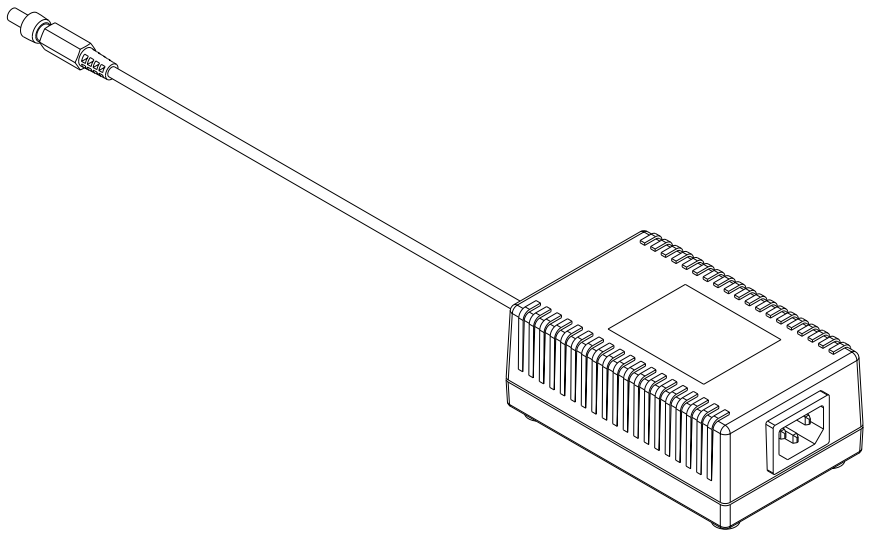


Optional Ceiling Tile Mount Hardware

Description	Part Number
Optional Ceiling Tile Mounting Kit	2002112-001
Optional Drywall Mounting Kit	2002112-002

Power Supply, PN 422766-001

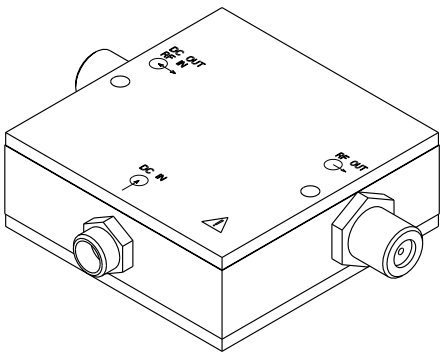
Power cords must be ordered separately. See Power Cords later in this chapter.



Power Supply Specifications	
Power Input: Output	 90-260Vac, 47 - 63Hz, male power inlet, 3 conductor, IEC 320 12Vdc, 2.5A, short circuit and overload protection
Operating Environment Temperature Humidity	 0 – 40° C 20 - 95% non-condensing
Storage Environment Temperature Humidity	 -40 – 75° C 10 -95% non-condensing
Isolation	Meets IEC 60601, classification BF, UL544 patient care, CSA 125 risk class 2G
Overall Regulation	< 5% no minimum load required
Maximum Ripple	< 100mVp-p
Cord Length	305mm (12 in.)
Safety	Approved to UL 544/2601.1, cUL (CSA) 22.2 #125/601.1, TUV EN60601.1 and CE LVD
EMC	Meets level B requirements of FCC part 15, CISPR11 (EN55011). Less than 1 volt output deviation for IEC801-2, 3, 4, 5 immunity tests.

Bias Tee, PN 2001546-001

NOTE: If using bias tee pn2001546-001 you must use GE Medical Systems *Information Technologies* power supply pn422766-001.

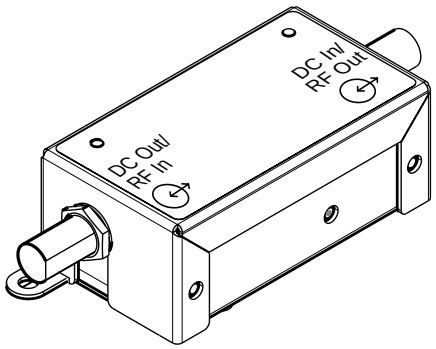


Bias Tee Specifications	
Frequency	400-650MHz
Insertion Loss	0.5dB, max
Isolation DC OUT/RF IN port to DC IN port RF OUT port to DC IN port	20dB, min
VSWR	1.3.1, max
DC Voltage	30 Volts, max
DC Current	1 Amp, max
RF Power	+20dBm, max
Temperature	0 - 55° C
DC Resistance	0.1 ohms

Antenna Amplifier, PN 2001727-00X

The antenna amplifier delivers 22dB of gain and draws 40mA of current. Green LED on the side indicates that the amp is receiving power. DC passing. Do not plug in backwards!

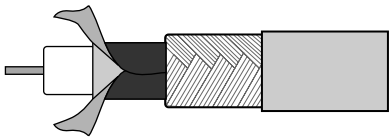
Description	Part Number
U.S. Antenna Amplifier (560–614 MHz)	2001727-001
International Antenna Amplifier (420-474 MHz)	2001727-002



Cabling

RG-6 and RG-11 Coaxial Cable

Recommended cabling is RG-6. Refer to Chapter 3, Site Survey and System Design, for cable losses.



75 Ohm Cable

Description	Part Number
RG-6 Riser	4907-001
RG-6 Plenum	4907-101
RG-11 Riser	4908-001
RG-11 Plenum	4908-101

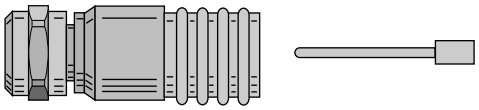
Coaxial Type	dB Loss/100 Ft @ 400 MHz	dB Loss/100 Ft @ 600 MHz
RG-6 Riser	4.0	5.1
RG-6 Plenum	4.5	5.7
RG-11 Riser	2.9	3.7
RG-11 Plenum	3.3	4.3

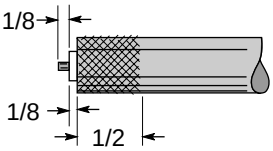
Coaxial Type	Ohms/1000 Ft	Ohms/Ft
RG-6 Riser	30	0.030
RG-6 Plenum	30	0.030
RG-11 Riser	13	0.013
RG-11 Plenum	13	0.013

Connectors

F-Type, RG-11, Riser Male Connector

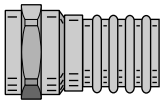
PN 1886-003

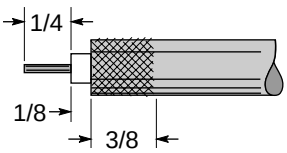




F-Type, RG-6, Riser Male Connector

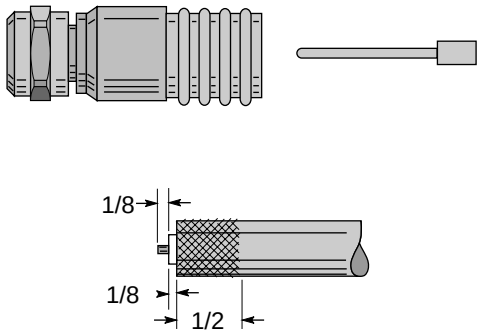
PN 1886-004





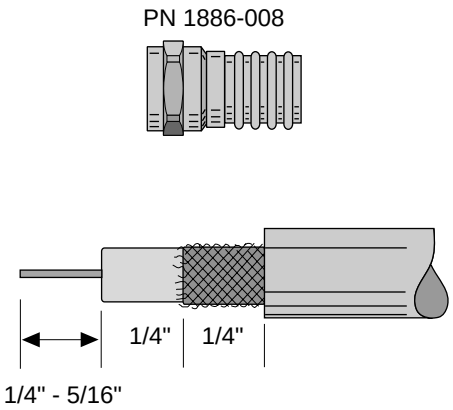
F-Type, RG-11, Plenum Male Connector

PN 1886-007



F-Type, RG-6, Plenum Male Connector

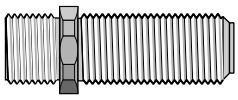
PN 1886-008



Adapters

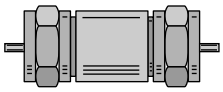
Female F – Female F Adapter

PN 1886-401



Male F – Male F Adapter

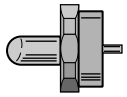
PN 1886-601



Block and Terminator

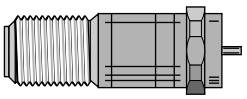
75 Ohm Terminator

PN 17100-001

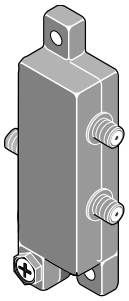


DC Power Block

PN 17102-001



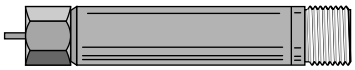
Splitters/Combiners



Description	Part Number
2:1 Splitter/combiner	2006947-001
4:1 Splitter/combiner	2006947-002
8:1 Splitter/combiner	2006947-003

Component	dB Loss/Gain	
	@ 474 MHz	@ 614 MHz
2:1 Splitter/Combiner	–4.8	–4.8
4:1 Splitter/Combiner	–8.4	–9.1
8:1 Splitter/Combiner	–15.0	–16.1

DC Passing Attenuators

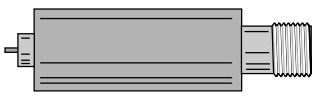


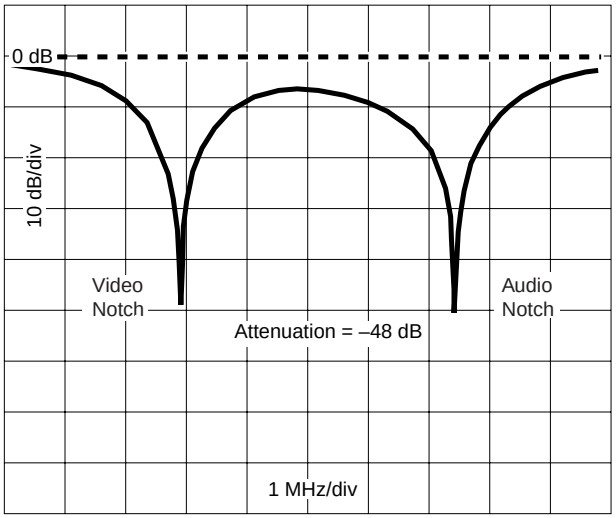
Description	Part Number
Passive Attenuator (3 dB loss)	401240-001
Passive Attenuator (6 dB loss)	401241-001
Passive Attenuator (10 dB loss)	17101-110
Passive Attenuator (20 dB loss)	401242-001

Notch Filters, PN 2005063-0xx

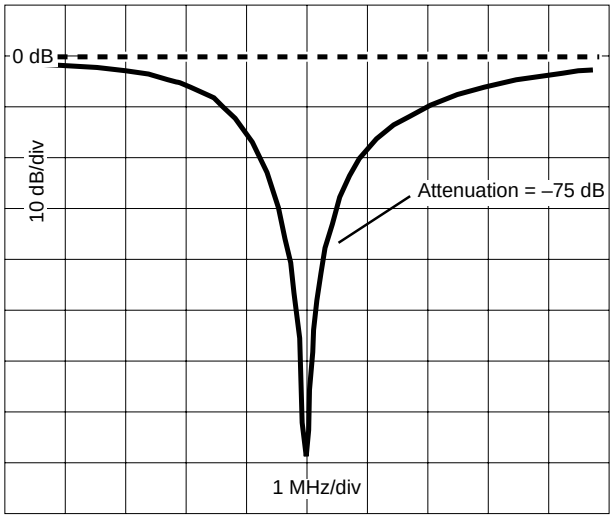
These notch filters have no active components and should not be used with +12 volts because they cannot pass DC voltage. The filter is sealed and tuned from the vendor for video and audio of a specific TV channel. Install the notch filter between the bias tee and the receiver system.

Description	Part Number
Notch Filter Channel 29 A/V	2005063-001
Notch Filter Channel 30 A/V	2005063-002
Notch Filter Channel 31 A/V	2005063-003
Notch Filter Channel 32 A/V	2005063-004
Notch Filter Channel 33 A/V	2005063-005
Notch Filter Channel 34 A/V	2005063-006
Notch Filter Channel 35 A/V	2005063-007
Notch Filter Channel 36 A/V	2005063-008
Notch Filter Channel 36 Video	2005063-009
Notch Filter Channel 38	2005063-010
Notch Filter Channel 26 A/V	2005063-011
Notch Filter Channel 27 A/V	2005063-012
Notch Filter Channel 28 A/V	2005063-013
Notch Filter Channel 39 A/V	2005063-014
Notch Filter Channel 40 A/V	2005063-015
Notch Filter Channel 41 A/V	2005063-016
Filter Low Pass 610 MHz	2005063-017
Filter High Pass 550 MHz	2005063-018



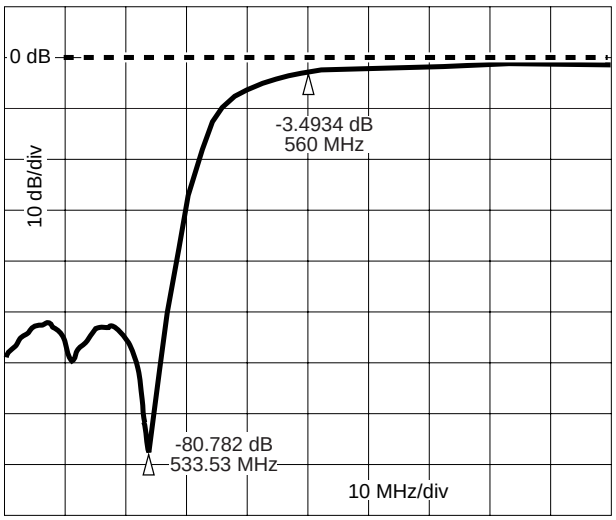


Notch Filter Channels 29 – 37

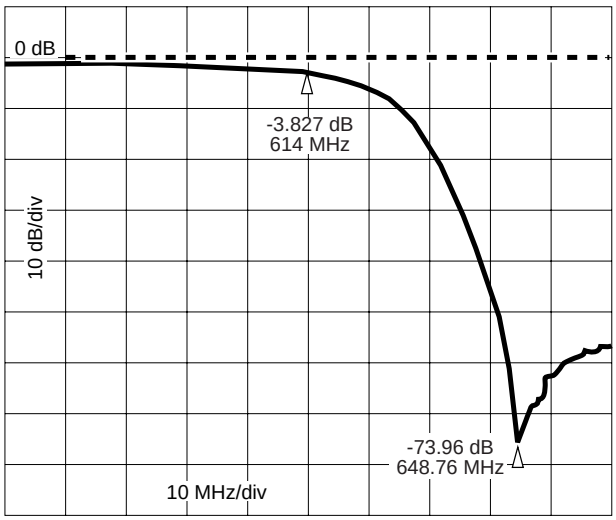


Notch Filter Channels 36 and 38

NOTE: **Do not** use the above filters with any transmitters within the specific TV channel. The entire channel is severely attenuated. Do not use frequencies 1.5 MHz below the video notch or 1.5 MHz above the audio notch.



High Pass Filter 560MHz



Low Pass Filter 614MHz

Power Cords

Use one power cord per power supply.

Description	Part Number
Power Cord, right angle, 125V, 12ft, 13A	405535-001
Power Cord, straight, 125V, 12ft	80274-002
Power Cord, straight, 125V, 6ft	80274-006
Power Cord, right angle cable,125V, 6ft, SE	80274-007
Power Cord, right angle cable,125V, 12ft, SE	80274-008
Power Cord, RA 125V 13A 12F	405535-001
Power Cord, Cont Euro, 10A 250V, 8ft	401855-001
Power Cord, British, 10A 250V, 8ft	401855-002
Power Cord, Italian, 10A 250V, 8ft	401855-003
Power Cord, Israeli, 10A 250V, 8ft	401855-004
Power Cord, Swiss, 10A 250V, 8ft	401855-007
Power Cord, Indian, 10A 250V, 8ft	401855-008
Power Cord, Danish, 220VAC/50HZ, stress	401855-009
Power Cord, Australian, 10A 250V, 8ft	401855-010
Power Cord, Cont Euro, 10A, 8ft, STR	401855-101
Power Cord, 125V 15A, 12ft, STR	405535-002

A Appendix A – TTX Frequency Charts

For your notes

International (420-474MHz)

ApexPro TTX List. Channel											
Ch.	**TTX#**	**Freq. (MHz)**	**S/N**	**Ch.**	**TTX#**	**Freq. (MHz)**	**S/N**	**Ch.**	**TTX#**	**Freq. (MHz)**	**S/N**
	1000	420.000	Reserved		1050	421.250			1100	422.500	
	1001	420.025			1051	421.275			1101	422.525	
	1002	420.050			1052	421.300			1102	422.550	
	1003	420.075			1053	421.325			1103	422.575	
	1004	420.100			1054	421.350			1104	422.600	
	1005	420.125			1055	421.375			1105	422.625	
	1006	420.150			1056	421.400			1106	422.650	
	1007	420.175			1057	421.425			1107	422.675	
	1008	420.200			1058	421.450			1108	422.700	
	1009	420.225			1059	421.475			1109	422.725	
	1010	420.250			1060	421.500			1110	422.750	
	1011	420.275			1061	421.525			1111	422.775	
	1012	420.300			1062	421.550			1112	422.800	
	1013	420.325			1063	421.575			1113	422.825	
	1014	420.350			1064	421.600			1114	422.850	
	1015	420.375			1065	421.625			1115	422.875	
	1016	420.400			1066	421.650			1116	422.900	
	1017	420.425			1067	421.675			1117	422.925	
	1018	420.450			1068	421.700			1118	422.950	
	1019	420.475			1069	421.725			1119	422.975	
	1020	420.500			1070	421.750			1120	423.000	
	1021	420.525			1071	421.775			1121	423.025	
	1022	420.550			1072	421.800			1122	423.050	
	1023	420.575			1073	421.825			1123	423.075	
	1024	420.600			1074	421.850			1124	423.100	
	1025	420.625			1075	421.875			1125	423.125	
	1026	420.650			1076	421.900			1126	423.150	
	1027	420.675			1077	421.925			1127	423.175	
	1028	420.700			1078	421.950			1128	423.200	
	1029	420.725			1079	421.975			1129	423.225	
	1030	420.750			1080	422.000			1130	423.250	
	1031	420.775			1081	422.025			1131	423.275	
	1032	420.800			1082	422.050			1132	423.300	
	1033	420.825			1083	422.075			1133	423.325	
	1034	420.850			1084	422.100			1134	423.350	
	1035	420.875			1085	422.125			1135	423.375	
	1036	420.900			1086	422.150			1136	423.400	
	1037	420.925			1087	422.175			1137	423.425	
	1038	420.950			1088	422.200			1138	423.450	
	1039	420.975			1089	422.225			1139	423.475	
	1040	421.000			1090	422.250			1140	423.500	
	1041	421.025			1091	422.275			1141	423.525	
	1042	421.050			1092	422.300			1142	423.550	
	1043	421.075			1093	422.325			1143	423.575	
	1044	421.100			1094	422.350			1144	423.600	
	1045	421.125			1095	422.375			1145	423.625	
	1046	421.150			1096	422.400			1146	423.650	
	1047	421.175			1097	422.425			1147	423.675	
	1048	421.200			1098	422.450			1148	423.700	
	1049	421.225			1099	422.475			1149	423.725	

	1150	423.750			1202	425.050			1254	426.350	
	1151	423.775			1203	425.075			1255	426.375	
	1152	423.800			1204	425.100			1256	426.400	
	1153	423.825			1205	425.125			1257	426.425	
	1154	423.850			1206	425.150			1258	426.450	
	1155	423.875			1207	425.175			1259	426.475	
	1156	423.900			1208	425.200			1260	426.500	
	1157	423.925			1209	425.225			1261	426.525	
	1158	423.950			1210	425.250			1262	426.550	
	1159	423.975			1211	425.275			1263	426.575	
	1160	424.000			1212	425.300			1264	426.600	
	1161	424.025			1213	425.325			1265	426.625	
	1162	424.050			1214	425.350			1266	426.650	
	1163	424.075			1215	425.375			1267	426.675	
	1164	424.100			1216	425.400			1268	426.700	
	1165	424.125			1217	425.425			1269	426.725	
	1166	424.150			1218	425.450			1270	426.750	
	1167	424.175			1219	425.475			1271	426.775	
	1168	424.200			1220	425.500			1272	426.800	
	1169	424.225			1221	425.525			1273	426.825	
	1170	424.250			1222	425.550			1274	426.850	
	1171	424.275			1223	425.575			1275	426.875	
	1172	424.300			1224	425.600			1276	426.900	
	1173	424.325			1225	425.625			1277	426.925	
	1174	424.350			1226	425.650			1278	426.950	
	1175	424.375			1227	425.675			1279	426.975	
	1176	424.400			1228	425.700			1280	427.000	
	1177	424.425			1229	425.725			1281	427.025	
	1178	424.450			1230	425.750			1282	427.050	
	1179	424.475			1231	425.775			1283	427.075	
	1180	424.500			1232	425.800			1284	427.100	
	1181	424.525			1233	425.825			1285	427.125	
	1182	424.550			1234	425.850			1286	427.150	
	1183	424.575			1235	425.875			1287	427.175	
	1184	424.600			1236	425.900			1288	427.200	
	1185	424.625			1237	425.925			1289	427.225	
	1186	424.650			1238	425.950			1290	427.250	
	1187	424.675			1239	425.975			1291	427.275	
	1188	424.700			1240	426.000			1292	427.300	
	1189	424.725			1241	426.025			1293	427.325	
	1190	424.750			1242	426.050			1294	427.350	
	1191	424.775			1243	426.075			1295	427.375	
	1192	424.800			1244	426.100			1296	427.400	
	1193	424.825			1245	426.125			1297	427.425	
	1194	424.850			1246	426.150			1298	427.450	
	1195	424.875			1247	426.175			1299	427.475	
	1196	424.900			1248	426.200			1300	427.500	
	1197	424.925			1249	426.225			1301	427.525	
	1198	424.950			1250	426.250			1302	427.550	
	1199	424.975			1251	426.275			1303	427.575	
	1200	425.000			1252	426.300			1304	427.600	
	1201	425.025			1253	426.325			1305	427.625	

	1306	427.650			1358	428.950			1410	430.250	
	1307	427.675			1359	428.975			1411	430.275	
	1308	427.700			1360	429.000			1412	430.300	
	1309	427.725			1361	429.025			1413	430.325	
	1310	427.750			1362	429.050			1414	430.350	
	1311	427.775			1363	429.075			1415	430.375	
	1312	427.800			1364	429.100			1416	430.400	
	1313	427.825			1365	429.125			1417	430.425	
	1314	427.850			1366	429.150			1418	430.450	
	1315	427.875			1367	429.175			1419	430.475	
	1316	427.900			1368	429.200			1420	430.500	
	1317	427.925			1369	429.225			1421	430.525	
	1318	427.950			1370	429.250			1422	430.550	
	1319	427.975			1371	429.275			1423	430.575	
	1320	428.000			1372	429.300			1424	430.600	
	1321	428.025			1373	429.325			1425	430.625	
	1322	428.050			1374	429.350			1426	430.650	
	1323	428.075			1375	429.375			1427	430.675	
	1324	428.100			1376	429.400			1428	430.700	
	1325	428.125			1377	429.425			1429	430.725	
	1326	428.150			1378	429.450			1430	430.750	
	1327	428.175			1379	429.475			1431	430.775	
	1328	428.200			1380	429.500			1432	430.800	
	1329	428.225			1381	429.525			1433	430.825	
	1330	428.250			1382	429.550			1434	430.850	
	1331	428.275			1383	429.575			1435	430.875	
	1332	428.300			1384	429.600			1436	430.900	
	1333	428.325			1385	429.625			1437	430.925	
	1334	428.350			1386	429.650			1438	430.950	
	1335	428.375			1387	429.675			1439	430.975	
	1336	428.400			1388	429.700			1440	431.000	
	1337	428.425			1389	429.725			1441	431.025	
	1338	428.450			1390	429.750			1442	431.050	
	1339	428.475			1391	429.775			1443	431.075	
	1340	428.500			1392	429.800			1444	431.100	
	1341	428.525			1393	429.825			1445	431.125	
	1342	428.550			1394	429.850			1446	431.150	
	1343	428.575			1395	429.875			1447	431.175	
	1344	428.600			1396	429.900			1448	431.200	
	1345	428.625			1397	429.925			1449	431.225	
	1346	428.650			1398	429.950			1450	431.250	
	1347	428.675			1399	429.975			1451	431.275	
	1348	428.700			1400	430.000			1452	431.300	
	1349	428.725			1401	430.025			1453	431.325	
	1350	428.750			1402	430.050			1454	431.350	
	1351	428.775			1403	430.075			1455	431.375	
	1352	428.800			1404	430.100			1456	431.400	
	1353	428.825			1405	430.125			1457	431.425	
	1354	428.850			1406	430.150			1458	431.450	
	1355	428.875			1407	430.175			1459	431.475	
	1356	428.900			1408	430.200			1460	431.500	
	1357	428.925			1409	430.225			1461	431.525	

	1462	431.550			1514	432.850			1566	434.150	
	1463	431.575			1515	432.875			1567	434.175	
	1464	431.600			1516	432.900			1568	434.200	
	1465	431.625			1517	432.925			1569	434.225	
	1466	431.650			1518	432.950			1570	434.250	
	1467	431.675			1519	432.975			1571	434.275	
	1468	431.700			1520	433.000			1572	434.300	
	1469	431.725			1521	433.025			1573	434.325	
	1470	431.750			1522	433.050			1574	434.350	
	1471	431.775			1523	433.075			1575	434.375	
	1472	431.800			1524	433.100			1576	434.400	
	1473	431.825			1525	433.125			1577	434.425	
	1474	431.850			1526	433.150			1578	434.450	
	1475	431.875			1527	433.175			1579	434.475	
	1476	431.900			1528	433.200			1580	434.500	
	1477	431.925			1529	433.225			1581	434.525	
	1478	431.950			1530	433.250			1582	434.550	
	1479	431.975			1531	433.275			1583	434.575	
	1480	432.000	Reserved		1532	433.300			1584	434.600	
	1481	432.025			1533	433.325			1585	434.625	
	1482	432.050			1534	433.350			1586	434.650	
	1483	432.075			1535	433.375			1587	434.675	
	1484	432.100			1536	433.400			1588	434.700	
	1485	432.125			1537	433.425			1589	434.725	
	1486	432.150			1538	433.450			1590	434.750	
	1487	432.175			1539	433.475			1591	434.775	
	1488	432.200			1540	433.500			1592	434.800	
	1489	432.225			1541	433.525			1593	434.825	
	1490	432.250			1542	433.550			1594	434.850	
	1491	432.275			1543	433.575			1595	434.875	
	1492	432.300			1544	433.600			1596	434.900	
	1493	432.325			1545	433.625			1597	434.925	
	1494	432.350			1546	433.650			1598	434.950	
	1495	432.375			1547	433.675			1599	434.975	
	1496	432.400			1548	433.700			1600	435.000	
	1497	432.425			1549	433.725			1601	435.025	
	1498	432.450			1550	433.750			1602	435.050	
	1499	432.475			1551	433.775			1603	435.075	
	1500	432.500			1552	433.800			1604	435.100	
	1501	432.525			1553	433.825			1605	435.125	
	1502	432.550			1554	433.850			1606	435.150	
	1503	432.575			1555	433.875			1607	435.175	
	1504	432.600			1556	433.900			1608	435.200	
	1505	432.625			1557	433.925			1609	435.225	
	1506	432.650			1558	433.950			1610	435.250	
	1507	432.675			1559	433.975			1611	435.275	
	1508	432.700			1560	434.000			1612	435.300	
	1509	432.725			1561	434.025			1613	435.325	
	1510	432.750			1562	434.050			1614	435.350	
	1511	432.775			1563	434.075			1615	435.375	
	1512	432.800			1564	434.100			1616	435.400	
	1513	432.825			1565	434.125			1617	435.425	

	1618	435.450			1670	436.750			1722	438.050	
	1619	435.475			1671	436.775			1723	438.075	
	1620	435.500			1672	436.800			1724	438.100	
	1621	435.525			1673	436.825			1725	438.125	
	1622	435.550			1674	436.850			1726	438.150	
	1623	435.575			1675	436.875			1727	438.175	
	1624	435.600			1676	436.900			1728	438.200	
	1625	435.625			1677	436.925			1729	438.225	
	1626	435.650			1678	436.950			1730	438.250	
	1627	435.675			1679	436.975			1731	438.275	
	1628	435.700			1680	437.000			1732	438.300	
	1629	435.725			1681	437.025			1733	438.325	
	1630	435.750			1682	437.050			1734	438.350	
	1631	435.775			1683	437.075			1735	438.375	
	1632	435.800			1684	437.100			1736	438.400	
	1633	435.825			1685	437.125			1737	438.425	
	1634	435.850			1686	437.150			1738	438.450	
	1635	435.875			1687	437.175			1739	438.475	
	1636	435.900			1688	437.200			1740	438.500	
	1637	435.925			1689	437.225			1741	438.525	
	1638	435.950			1690	437.250			1742	438.550	
	1639	435.975			1691	437.275			1743	438.575	
	1640	436.000			1692	437.300			1744	438.600	
	1641	436.025			1693	437.325			1745	438.625	
	1642	436.050			1694	437.350			1746	438.650	
	1643	436.075			1695	437.375			1747	438.675	
	1644	436.100			1696	437.400			1748	438.700	
	1645	436.125			1697	437.425			1749	438.725	
	1646	436.150			1698	437.450			1750	438.750	
	1647	436.175			1699	437.475			1751	438.775	
	1648	436.200			1700	437.500			1752	438.800	
	1649	436.225			1701	437.525			1753	438.825	
	1650	436.250			1702	437.550			1754	438.850	
	1651	436.275			1703	437.575			1755	438.875	
	1652	436.300			1704	437.600			1756	438.900	
	1653	436.325			1705	437.625			1757	438.925	
	1654	436.350			1706	437.650			1758	438.950	
	1655	436.375			1707	437.675			1759	438.975	
	1656	436.400			1708	437.700			1760	439.000	
	1657	436.425			1709	437.725			1761	439.025	
	1658	436.450			1710	437.750			1762	439.050	
	1659	436.475			1711	437.775			1763	439.075	
	1660	436.500			1712	437.800			1764	439.100	
	1661	436.525			1713	437.825			1765	439.125	
	1662	436.550			1714	437.850			1766	439.150	
	1663	436.575			1715	437.875			1767	439.175	
	1664	436.600			1716	437.900			1768	439.200	
	1665	436.625			1717	437.925			1769	439.225	
	1666	436.650			1718	437.950			1770	439.250	
	1667	436.675			1719	437.975			1771	439.275	
	1668	436.700			1720	438.000			1772	439.300	
	1669	436.725			1721	438.025			1773	439.325	

	1774	439.350			1826	440.650			1878	441.950	
	1775	439.375			1827	440.675			1879	441.975	
	1776	439.400			1828	440.700			1880	442.000	
	1777	439.425			1829	440.725			1881	442.025	
	1778	439.450			1830	440.750			1882	442.050	
	1779	439.475			1831	440.775			1883	442.075	
	1780	439.500			1832	440.800			1884	442.100	
	1781	439.525			1833	440.825			1885	442.125	
	1782	439.550			1834	440.850			1886	442.150	
	1783	439.575			1835	440.875			1887	442.175	
	1784	439.600			1836	440.900			1888	442.200	
	1785	439.625			1837	440.925			1889	442.225	
	1786	439.650			1838	440.950			1890	442.250	
	1787	439.675			1839	440.975			1891	442.275	
	1788	439.700			1840	441.000			1892	442.300	
	1789	439.725			1841	441.025			1893	442.325	
	1790	439.750			1842	441.050			1894	442.350	
	1791	439.775			1843	441.075			1895	442.375	
	1792	439.800			1844	441.100			1896	442.400	
	1793	439.825			1845	441.125			1897	442.425	
	1794	439.850			1846	441.150			1898	442.450	
	1795	439.875			1847	441.175			1899	442.475	
	1796	439.900			1848	441.200			1900	442.500	
	1797	439.925			1849	441.225			1901	442.525	
	1798	439.950			1850	441.250			1902	442.550	
	1799	439.975			1851	441.275			1903	442.575	
	1800	440.000			1852	441.300			1904	442.600	
	1801	440.025			1853	441.325			1905	442.625	
	1802	440.050			1854	441.350			1906	442.650	
	1803	440.075			1855	441.375			1907	442.675	
	1804	440.100			1856	441.400			1908	442.700	
	1805	440.125			1857	441.425			1909	442.725	
	1806	440.150			1858	441.450			1910	442.750	
	1807	440.175			1859	441.475			1911	442.775	
	1808	440.200			1860	441.500			1912	442.800	
	1809	440.225			1861	441.525			1913	442.825	
	1810	440.250			1862	441.550			1914	442.850	
	1811	440.275			1863	441.575			1915	442.875	
	1812	440.300			1864	441.600			1916	442.900	
	1813	440.325			1865	441.625			1917	442.925	
	1814	440.350			1866	441.650			1918	442.950	
	1815	440.375			1867	441.675			1919	442.975	
	1816	440.400			1868	441.700			1920	443.000	
	1817	440.425			1869	441.725			1921	443.025	
	1818	440.450			1870	441.750			1922	443.050	
	1819	440.475			1871	441.775			1923	443.075	
	1820	440.500			1872	441.800			1924	443.100	
	1821	440.525			1873	441.825			1925	443.125	
	1822	440.550			1874	441.850			1926	443.150	
	1823	440.575			1875	441.875			1927	443.175	
	1824	440.600			1876	441.900			1928	443.200	
	1825	440.625			1877	441.925			1929	443.225	

	1930	443.250			1982	444.550			2034	445.850	
	1931	443.275			1983	444.575			2035	445.875	
	1932	443.300			1984	444.600			2036	445.900	
	1933	443.325			1985	444.625			2037	445.925	
	1934	443.350			1986	444.650			2038	445.950	
	1935	443.375			1987	444.675			2039	445.975	
	1936	443.400			1988	444.700			2040	446.000	
	1937	443.425			1989	444.725			2041	446.025	
	1938	443.450			1990	444.750			2042	446.050	
	1939	443.475			1991	444.775			2043	446.075	
	1940	443.500			1992	444.800			2044	446.100	
	1941	443.525			1993	444.825			2045	446.125	
	1942	443.550			1994	444.850			2046	446.150	
	1943	443.575			1995	444.875			2047	446.175	
	1944	443.600			1996	444.900			2048	446.200	
	1945	443.625			1997	444.925			2049	446.225	
	1946	443.650			1998	444.950			2050	446.250	
	1947	443.675			1999	444.975			2051	446.275	
	1948	443.700			2000	445.000			2052	446.300	
	1949	443.725			2001	445.025			2053	446.325	
	1950	443.750			2002	445.050			2054	446.350	
	1951	443.775			2003	445.075			2055	446.375	
	1952	443.800			2004	445.100			2056	446.400	Reserved
	1953	443.825			2005	445.125			2057	446.425	
	1954	443.850			2006	445.150			2058	446.450	
	1955	443.875			2007	445.175			2059	446.475	
	1956	443.900			2008	445.200			2060	446.500	
	1957	443.925			2009	445.225			2061	446.525	
	1958	443.950			2010	445.250			2062	446.550	
	1959	443.975			2011	445.275			2063	446.575	
	1960	444.000			2012	445.300			2064	446.600	
	1961	444.025			2013	445.325			2065	446.625	
	1962	444.050			2014	445.350			2066	446.650	
	1963	444.075			2015	445.375			2067	446.675	
	1964	444.100			2016	445.400			2068	446.700	
	1965	444.125			2017	445.425			2069	446.725	
	1966	444.150			2018	445.450			2070	446.750	
	1967	444.175			2019	445.475			2071	446.775	
	1968	444.200			2020	445.500			2072	446.800	
	1969	444.225			2021	445.525			2073	446.825	
	1970	444.250			2022	445.550			2074	446.850	
	1971	444.275			2023	445.575			2075	446.875	
	1972	444.300			2024	445.600			2076	446.900	
	1973	444.325			2025	445.625			2077	446.925	
	1974	444.350			2026	445.650			2078	446.950	
	1975	444.375			2027	445.675			2079	446.975	
	1976	444.400			2028	445.700			2080	447.000	
	1977	444.425			2029	445.725			2081	447.025	
	1978	444.450			2030	445.750			2082	447.050	
	1979	444.475			2031	445.775			2083	447.075	
	1980	444.500			2032	445.800			2084	447.100	
	1981	444.525			2033	445.825			2085	447.125	

	2086	447.150			2138	448.450			2190	449.750	
	2087	447.175			2139	448.475			2191	449.775	
	2088	447.200			2140	448.500			2192	449.800	
	2089	447.225			2141	448.525			2193	449.825	
	2090	447.250			2142	448.550			2194	449.850	
	2091	447.275			2143	448.575			2195	449.875	
	2092	447.300			2144	448.600			2196	449.900	
	2093	447.325			2145	448.625			2197	449.925	
	2094	447.350			2146	448.650			2198	449.950	
	2095	447.375			2147	448.675			2199	449.975	
	2096	447.400			2148	448.700			2200	450.000	Reserved
	2097	447.425			2149	448.725			2201	450.025	
	2098	447.450			2150	448.750			2202	450.050	
	2099	447.475			2151	448.775			2203	450.075	
	2100	447.500			2152	448.800			2204	450.100	
	2101	447.525			2153	448.825			2205	450.125	
	2102	447.550			2154	448.850			2206	450.150	
	2103	447.575			2155	448.875			2207	450.175	
	2104	447.600			2156	448.900			2208	450.200	
	2105	447.625			2157	448.925			2209	450.225	
	2106	447.650			2158	448.950			2210	450.250	
	2107	447.675			2159	448.975			2211	450.275	
	2108	447.700			2160	449.000			2212	450.300	
	2109	447.725			2161	449.025			2213	450.325	
	2110	447.750			2162	449.050			2214	450.350	
	2111	447.775			2163	449.075			2215	450.375	
	2112	447.800			2164	449.100			2216	450.400	
	2113	447.825			2165	449.125			2217	450.425	
	2114	447.850			2166	449.150			2218	450.450	
	2115	447.875			2167	449.175			2219	450.475	
	2116	447.900			2168	449.200			2220	450.500	
	2117	447.925			2169	449.225			2221	450.525	
	2118	447.950			2170	449.250			2222	450.550	
	2119	447.975			2171	449.275			2223	450.575	
	2120	448.000			2172	449.300			2224	450.600	
	2121	448.025			2173	449.325			2225	450.625	
	2122	448.050			2174	449.350			2226	450.650	
	2123	448.075			2175	449.375			2227	450.675	
	2124	448.100			2176	449.400			2228	450.700	
	2125	448.125			2177	449.425			2229	450.725	
	2126	448.150			2178	449.450			2230	450.750	
	2127	448.175			2179	449.475			2231	450.775	
	2128	448.200			2180	449.500			2232	450.800	
	2129	448.225			2181	449.525			2233	450.825	
	2130	448.250			2182	449.550			2234	450.850	
	2131	448.275			2183	449.575			2235	450.875	
	2132	448.300			2184	449.600			2236	450.900	
	2133	448.325			2185	449.625			2237	450.925	
	2134	448.350			2186	449.650			2238	450.950	
	2135	448.375			2187	449.675			2239	450.975	
	2136	448.400			2188	449.700			2240	451.000	
	2137	448.425			2189	449.725			2241	451.025	

	2242	451.050			2294	452.350			2346	453.650	
	2243	451.075			2295	452.375			2347	453.675	
	2244	451.100			2296	452.400			2348	453.700	
	2245	451.125			2297	452.425			2349	453.725	
	2246	451.150			2298	452.450			2350	453.750	
	2247	451.175			2299	452.475			2351	453.775	
	2248	451.200			2300	452.500			2352	453.800	
	2249	451.225			2301	452.525			2353	453.825	
	2250	451.250			2302	452.550			2354	453.850	
	2251	451.275			2303	452.575			2355	453.875	
	2252	451.300			2304	452.600			2356	453.900	
	2253	451.325			2305	452.625			2357	453.925	
	2254	451.350			2306	452.650			2358	453.950	
	2255	451.375			2307	452.675			2359	453.975	
	2256	451.400			2308	452.700			2360	454.000	
	2257	451.425			2309	452.725			2361	454.025	
	2258	451.450			2310	452.750			2362	454.050	
	2259	451.475			2311	452.775			2363	454.075	
	2260	451.500			2312	452.800			2364	454.100	
	2261	451.525			2313	452.825			2365	454.125	
	2262	451.550			2314	452.850			2366	454.150	
	2263	451.575			2315	452.875			2367	454.175	
	2264	451.600			2316	452.900			2368	454.200	
	2265	451.625			2317	452.925			2369	454.225	
	2266	451.650			2318	452.950			2370	454.250	
	2267	451.675			2319	452.975			2371	454.275	
	2268	451.700			2320	453.000			2372	454.300	
	2269	451.725			2321	453.025			2373	454.325	
	2270	451.750			2322	453.050			2374	454.350	
	2271	451.775			2323	453.075			2375	454.375	
	2272	451.800			2324	453.100			2376	454.400	
	2273	451.825			2325	453.125			2377	454.425	
	2274	451.850			2326	453.150			2378	454.450	
	2275	451.875			2327	453.175			2379	454.475	
	2276	451.900			2328	453.200			2380	454.500	
	2277	451.925			2329	453.225			2381	454.525	
	2278	451.950			2330	453.250			2382	454.550	
	2279	451.975			2331	453.275			2383	454.575	
	2280	452.000			2332	453.300			2384	454.600	
	2281	452.025			2333	453.325			2385	454.625	
	2282	452.050			2334	453.350			2386	454.650	
	2283	452.075			2335	453.375			2387	454.675	
	2284	452.100			2336	453.400			2388	454.700	
	2285	452.125			2337	453.425			2389	454.725	
	2286	452.150			2338	453.450			2390	454.750	
	2287	452.175			2339	453.475			2391	454.775	
	2288	452.200			2340	453.500			2392	454.800	
	2289	452.225			2341	453.525			2393	454.825	
	2290	452.250			2342	453.550			2394	454.850	
	2291	452.275			2343	453.575			2395	454.875	
	2292	452.300			2344	453.600			2396	454.900	
	2293	452.325			2345	453.625			2397	454.925	

	2398	454.950			2450	456.250			2502	457.550	
	2399	454.975			2451	456.275			2503	457.575	
	2400	455.000			2452	456.300			2504	457.600	
	2401	455.025			2453	456.325			2505	457.625	
	2402	455.050			2454	456.350			2506	457.650	
	2403	455.075			2455	456.375			2507	457.675	
	2404	455.100			2456	456.400			2508	457.700	
	2405	455.125			2457	456.425			2509	457.725	
	2406	455.150			2458	456.450			2510	457.750	
	2407	455.175			2459	456.475			2511	457.775	
	2408	455.200			2460	456.500			2512	457.800	
	2409	455.225			2461	456.525			2513	457.825	
	2410	455.250			2462	456.550			2514	457.850	
	2411	455.275			2463	456.575			2515	457.875	
	2412	455.300			2464	456.600			2516	457.900	
	2413	455.325			2465	456.625			2517	457.925	
	2414	455.350			2466	456.650			2518	457.950	
	2415	455.375			2467	456.675			2519	457.975	
	2416	455.400			2468	456.700			2520	458.000	
	2417	455.425			2469	456.725			2521	458.025	
	2418	455.450			2470	456.750			2522	458.050	
	2419	455.475			2471	456.775			2523	458.075	
	2420	455.500			2472	456.800			2524	458.100	
	2421	455.525			2473	456.825			2525	458.125	
	2422	455.550			2474	456.850			2526	458.150	
	2423	455.575			2475	456.875			2527	458.175	
	2424	455.600			2476	456.900			2528	458.200	
	2425	455.625			2477	456.925			2529	458.225	
	2426	455.650			2478	456.950			2530	458.250	
	2427	455.675			2479	456.975			2531	458.275	
	2428	455.700			2480	457.000			2532	458.300	
	2429	455.725			2481	457.025			2533	458.325	
	2430	455.750			2482	457.050			2534	458.350	
	2431	455.775			2483	457.075			2535	458.375	
	2432	455.800			2484	457.100			2536	458.400	
	2433	455.825			2485	457.125			2537	458.425	
	2434	455.850			2486	457.150			2538	458.450	
	2435	455.875			2487	457.175			2539	458.475	
	2436	455.900			2488	457.200			2540	458.500	
	2437	455.925			2489	457.225			2541	458.525	
	2438	455.950			2490	457.250			2542	458.550	
	2439	455.975			2491	457.275			2543	458.575	
	2440	456.000			2492	457.300			2544	458.600	
	2441	456.025			2493	457.325			2545	458.625	
	2442	456.050			2494	457.350			2546	458.650	
	2443	456.075			2495	457.375			2547	458.675	
	2444	456.100			2496	457.400			2548	458.700	
	2445	456.125			2497	457.425			2549	458.725	
	2446	456.150			2498	457.450			2550	458.750	
	2447	456.175			2499	457.475			2551	458.775	
	2448	456.200			2500	457.500			2552	458.800	
	2449	456.225			2501	457.525			2553	458.825	

	2554	458.850			2606	460.150			2658	461.450	
	2555	458.875			2607	460.175			2659	461.475	
	2556	458.900			2608	460.200			2660	461.500	
	2557	458.925			2609	460.225			2661	461.525	
	2558	458.950			2610	460.250			2662	461.550	
	2559	458.975			2611	460.275			2663	461.575	
	2560	459.000			2612	460.300			2664	461.600	
	2561	459.025			2613	460.325			2665	461.625	
	2562	459.050			2614	460.350			2666	461.650	
	2563	459.075			2615	460.375			2667	461.675	
	2564	459.100			2616	460.400			2668	461.700	
	2565	459.125			2617	460.425			2669	461.725	
	2566	459.150			2618	460.450			2670	461.750	
	2567	459.175			2619	460.475			2671	461.775	
	2568	459.200			2620	460.500			2672	461.800	
	2569	459.225			2621	460.525			2673	461.825	
	2570	459.250			2622	460.550			2674	461.850	
	2571	459.275			2623	460.575			2675	461.875	
	2572	459.300			2624	460.600			2676	461.900	
	2573	459.325			2625	460.625			2677	461.925	
	2574	459.350			2626	460.650			2678	461.950	
	2575	459.375			2627	460.675			2679	461.975	
	2576	459.400			2628	460.700			2680	462.000	
	2577	459.425			2629	460.725			2681	462.025	
	2578	459.450			2630	460.750			2682	462.050	
	2579	459.475			2631	460.775			2683	462.075	
	2580	459.500			2632	460.800			2684	462.100	
	2581	459.525			2633	460.825			2685	462.125	
	2582	459.550			2634	460.850			2686	462.150	
	2583	459.575			2635	460.875			2687	462.175	
	2584	459.600			2636	460.900			2688	462.200	
	2585	459.625			2637	460.925			2689	462.225	
	2586	459.650			2638	460.950			2690	462.250	
	2587	459.675			2639	460.975			2691	462.275	
	2588	459.700			2640	461.000			2692	462.300	
	2589	459.725			2641	461.025			2693	462.325	
	2590	459.750			2642	461.050			2694	462.350	
	2591	459.775			2643	461.075			2695	462.375	
	2592	459.800			2644	461.100			2696	462.400	
	2593	459.825			2645	461.125			2697	462.425	
	2594	459.850			2646	461.150			2698	462.450	
	2595	459.875			2647	461.175			2699	462.475	
	2596	459.900			2648	461.200			2700	462.500	
	2597	459.925			2649	461.225			2701	462.525	
	2598	459.950			2650	461.250			2702	462.550	
	2599	459.975			2651	461.275			2703	462.575	
	2600	460.000			2652	461.300			2704	462.600	
	2601	460.025			2653	461.325			2705	462.625	
	2602	460.050			2654	461.350			2706	462.650	
	2603	460.075			2655	461.375			2707	462.675	
	2604	460.100			2656	461.400			2708	462.700	
	2605	460.125			2657	461.425			2709	462.725	

	2710	462.750			2762	464.050			2814	465.350	
	2711	462.775			2763	464.075			2815	465.375	
	2712	462.800			2764	464.100			2816	465.400	
	2713	462.825			2765	464.125			2817	465.425	
	2714	462.850			2766	464.150			2818	465.450	
	2715	462.875			2767	464.175			2819	465.475	
	2716	462.900			2768	464.200			2820	465.500	
	2717	462.925			2769	464.225			2821	465.525	
	2718	462.950			2770	464.250			2822	465.550	
	2719	462.975			2771	464.275			2823	465.575	
	2720	463.000			2772	464.300			2824	465.600	
	2721	463.025			2773	464.325			2825	465.625	
	2722	463.050			2774	464.350			2826	465.650	
	2723	463.075			2775	464.375			2827	465.675	
	2724	463.100			2776	464.400			2828	465.700	
	2725	463.125			2777	464.425			2829	465.725	
	2726	463.150			2778	464.450			2830	465.750	
	2727	463.175			2779	464.475			2831	465.775	
	2728	463.200			2780	464.500			2832	465.800	
	2729	463.225			2781	464.525			2833	465.825	
	2730	463.250			2782	464.550			2834	465.850	
	2731	463.275			2783	464.575			2835	465.875	
	2732	463.300			2784	464.600			2836	465.900	
	2733	463.325			2785	464.625			2837	465.925	
	2734	463.350			2786	464.650			2838	465.950	
	2735	463.375			2787	464.675			2839	465.975	
	2736	463.400			2788	464.700			2840	466.000	
	2737	463.425			2789	464.725			2841	466.025	
	2738	463.450			2790	464.750			2842	466.050	
	2739	463.475			2791	464.775			2843	466.075	
	2740	463.500			2792	464.800			2844	466.100	
	2741	463.525			2793	464.825			2845	466.125	
	2742	463.550			2794	464.850			2846	466.150	
	2743	463.575			2795	464.875			2847	466.175	
	2744	463.600			2796	464.900			2848	466.200	
	2745	463.625			2797	464.925			2849	466.225	
	2746	463.650			2798	464.950			2850	466.250	
	2747	463.675			2799	464.975			2851	466.275	
	2748	463.700			2800	465.000			2852	466.300	
	2749	463.725			2801	465.025			2853	466.325	
	2750	463.750			2802	465.050			2854	466.350	
	2751	463.775			2803	465.075			2855	466.375	
	2752	463.800			2804	465.100			2856	466.400	
	2753	463.825			2805	465.125			2857	466.425	
	2754	463.850			2806	465.150			2858	466.450	
	2755	463.875			2807	465.175			2859	466.475	
	2756	463.900			2808	465.200			2860	466.500	
	2757	463.925			2809	465.225			2861	466.525	
	2758	463.950			2810	465.250			2862	466.550	
	2759	463.975			2811	465.275			2863	466.575	
	2760	464.000			2812	465.300			2864	466.600	
	2761	464.025			2813	465.325			2865	466.625	

	2866	466.650			2918	467.950			2970	469.250	
	2867	466.675			2919	467.975			2971	469.275	
	2868	466.700			2920	468.000			2972	469.300	
	2869	466.725			2921	468.025			2973	469.325	
	2870	466.750			2922	468.050			2974	469.350	
	2871	466.775			2923	468.075			2975	469.375	
	2872	466.800			2924	468.100			2976	469.400	
	2873	466.825			2925	468.125			2977	469.425	
	2874	466.850			2926	468.150			2978	469.450	
	2875	466.875			2927	468.175			2979	469.475	
	2876	466.900			2928	468.200			2980	469.500	
	2877	466.925			2929	468.225			2981	469.525	
	2878	466.950			2930	468.250			2982	469.550	
	2879	466.975			2931	468.275			2983	469.575	
	2880	467.000			2932	468.300			2984	469.600	
	2881	467.025			2933	468.325			2985	469.625	
	2882	467.050			2934	468.350			2986	469.650	
	2883	467.075			2935	468.375			2987	469.675	
	2884	467.100			2936	468.400			2988	469.700	
	2885	467.125			2937	468.425			2989	469.725	
	2886	467.150			2938	468.450			2990	469.750	
	2887	467.175			2939	468.475			2991	469.775	
	2888	467.200			2940	468.500			2992	469.800	
	2889	467.225			2941	468.525			2993	469.825	
	2890	467.250			2942	468.550			2994	469.850	
	2891	467.275			2943	468.575			2995	469.875	
	2892	467.300			2944	468.600			2996	469.900	
	2893	467.325			2945	468.625			2997	469.925	
	2894	467.350			2946	468.650			2998	469.950	
	2895	467.375			2947	468.675			2999	469.975	
	2896	467.400			2948	468.700			3000	470.000	
	2897	467.425			2949	468.725			3001	470.025	
	2898	467.450			2950	468.750			3002	470.050	
	2899	467.475			2951	468.775			3003	470.075	
	2900	467.500			2952	468.800			3004	470.100	
	2901	467.525			2953	468.825			3005	470.125	
	2902	467.550			2954	468.850			3006	470.150	
	2903	467.575			2955	468.875			3007	470.175	
	2904	467.600			2956	468.900			3008	470.200	
	2905	467.625			2957	468.925			3009	470.225	
	2906	467.650			2958	468.950			3010	470.250	
	2907	467.675			2959	468.975			3011	470.275	
	2908	467.700			2960	469.000			3012	470.300	
	2909	467.725			2961	469.025			3013	470.325	
	2910	467.750			2962	469.050			3014	470.350	
	2911	467.775			2963	469.075			3015	470.375	
	2912	467.800			2964	469.100			3016	470.400	
	2913	467.825			2965	469.125			3017	470.425	
	2914	467.850			2966	469.150			3018	470.450	
	2915	467.875			2967	469.175			3019	470.475	
	2916	467.900			2968	469.200			3020	470.500	
	2917	467.925			2969	469.225			3021	470.525	

	3022	470.550			3074	471.850			3126	473.150	
	3023	470.575			3075	471.875			3127	473.175	
	3024	470.600			3076	471.900			3128	473.200	
	3025	470.625			3077	471.925			3129	473.225	
	3026	470.650			3078	471.950			3130	473.250	
	3027	470.675			3079	471.975			3131	473.275	
	3028	470.700			3080	472.000			3132	473.300	
	3029	470.725			3081	472.025			3133	473.325	
	3030	470.750			3082	472.050			3134	473.350	
	3031	470.775			3083	472.075			3135	473.375	
	3032	470.800			3084	472.100			3136	473.400	
	3033	470.825			3085	472.125			3137	473.425	
	3034	470.850			3086	472.150			3138	473.450	
	3035	470.875			3087	472.175			3139	473.475	
	3036	470.900			3088	472.200			3140	473.500	
	3037	470.925			3089	472.225			3141	473.525	
	3038	470.950			3090	472.250			3142	473.550	
	3039	470.975			3091	472.275			3143	473.575	
	3040	471.000			3092	472.300			3144	473.600	
	3041	471.025			3093	472.325			3145	473.625	
	3042	471.050			3094	472.350			3146	473.650	
	3043	471.075			3095	472.375			3147	473.675	
	3044	471.100			3096	472.400			3148	473.700	
	3045	471.125			3097	472.425			3149	473.725	
	3046	471.150			3098	472.450			3150	473.750	
	3047	471.175			3099	472.475			3151	473.775	
	3048	471.200			3100	472.500			3152	473.800	
	3049	471.225			3101	472.525			3153	473.825	
	3050	471.250			3102	472.550			3154	473.850	
	3051	471.275			3103	472.575			3155	473.875	
	3052	471.300			3104	472.600			3156	473.900	
	3053	471.325			3105	472.625			3157	473.925	
	3054	471.350			3106	472.650			3158	473.950	
	3055	471.375			3107	472.675			3159	473.975	
	3056	471.400			3108	472.700			3160	474.000	
	3057	471.425			3109	472.725					
	3058	471.450			3110	472.750					
	3059	471.475			3111	472.775					
	3060	471.500			3112	472.800					
	3061	471.525			3113	472.825					
	3062	471.550			3114	472.850					
	3063	471.575			3115	472.875					
	3064	471.600			3116	472.900					
	3065	471.625			3117	472.925					
	3066	471.650			3118	472.950					
	3067	471.675			3119	472.975					
	3068	471.700			3120	473.000					
	3069	471.725			3121	473.025					
	3070	471.750			3122	473.050					
	3071	471.775			3123	473.075					
	3072	471.800			3124	473.100					
	3073	471.825			3125	473.125					

U.S. (560-614MHz)

ApexPro TTX List. Channel											
Ch.	**TTX#**	**Freq. (MHz)**	**S/N**	**Ch.**	**TTX#**	**Freq. (MHz)**	**S/N**	**Ch.**	**TTX#**	**Freq. (MHz)**	**S/N**
29	6600	560.000	Reserved	29	6650	561.250		29	6700	562.500	
29	6601	560.025		29	6651	561.275		29	6701	562.525	
29	6602	560.050		29	6652	561.300		29	6702	562.550	
29	6603	560.075		29	6653	561.325		29	6703	562.575	
29	6604	560.100		29	6654	561.350		29	6704	562.600	
29	6605	560.125		29	6655	561.375		29	6705	562.625	
29	6606	560.150		29	6656	561.400		29	6706	562.650	
29	6607	560.175		29	6657	561.425		29	6707	562.675	
29	6608	560.200		29	6658	561.450		29	6708	562.700	
29	6609	560.225		29	6659	561.475		29	6709	562.725	
29	6610	560.250		29	6660	561.500		29	6710	562.750	
29	6611	560.275		29	6661	561.525		29	6711	562.775	
29	6612	560.300		29	6662	561.550		29	6712	562.800	
29	6613	560.325		29	6663	561.575		29	6713	562.825	
29	6614	560.350		29	6664	561.600	Reserved	29	6714	562.850	
29	6615	560.375		29	6665	561.625		29	6715	562.875	
29	6616	560.400		29	6666	561.650		29	6716	562.900	
29	6617	560.425		29	6667	561.675		29	6717	562.925	
29	6618	560.450		29	6668	561.700		29	6718	562.950	
29	6619	560.475		29	6669	561.725		29	6719	562.975	
29	6620	560.500		29	6670	561.750		29	6720	563.000	
29	6621	560.525		29	6671	561.775		29	6721	563.025	
29	6622	560.550		29	6672	561.800		29	6722	563.050	
29	6623	560.575		29	6673	561.825		29	6723	563.075	
29	6624	560.600		29	6674	561.850		29	6724	563.100	
29	6625	560.625		29	6675	561.875		29	6725	563.125	
29	6626	560.650		29	6676	561.900		29	6726	563.150	
29	6627	560.675		29	6677	561.925		29	6727	563.175	
29	6628	560.700		29	6678	561.950		29	6728	563.200	
29	6629	560.725		29	6679	561.975		29	6729	563.225	
29	6630	560.750		29	6680	562.000		29	6730	563.250	
29	6631	560.775		29	6681	562.025		29	6731	563.275	
29	6632	560.800		29	6682	562.050		29	6732	563.300	
29	6633	560.825		29	6683	562.075		29	6733	563.325	
29	6634	560.850		29	6684	562.100		29	6734	563.350	
29	6635	560.875		29	6685	562.125		29	6735	563.375	
29	6636	560.900		29	6686	562.150		29	6736	563.400	
29	6637	560.925		29	6687	562.175		29	6737	563.425	
29	6638	560.950		29	6688	562.200		29	6738	563.450	
29	6639	560.975		29	6689	562.225		29	6739	563.475	
29	6640	561.000		29	6690	562.250		29	6740	563.500	
29	6641	561.025		29	6691	562.275		29	6741	563.525	
29	6642	561.050		29	6692	562.300		29	6742	563.550	
29	6643	561.075		29	6693	562.325		29	6743	563.575	
29	6644	561.100		29	6694	562.350		29	6744	563.600	
29	6645	561.125		29	6695	562.375		29	6745	563.625	
29	6646	561.150		29	6696	562.400		29	6746	563.650	
29	6647	561.175		29	6697	562.425		29	6747	563.675	
29	6648	561.200		29	6698	562.450		29	6748	563.700	
29	6649	561.225		29	6699	562.475		29	6749	563.725	

29	6750	563.750		29	6802	565.050		30	6854	566.350	
29	6751	563.775		29	6803	565.075		30	6855	566.375	
29	6752	563.800		29	6804	565.100		30	6856	566.400	
29	6753	563.825		29	6805	565.125		30	6857	566.425	
29	6754	563.850		29	6806	565.150		30	6858	566.450	
29	6755	563.875		29	6807	565.175		30	6859	566.475	
29	6756	563.900		29	6808	565.200		30	6860	566.500	
29	6757	563.925		29	6809	565.225		30	6861	566.525	
29	6758	563.950		29	6810	565.250		30	6862	566.550	
29	6759	563.975		29	6811	565.275		30	6863	566.575	
29	6760	564.000		29	6812	565.300		30	6864	566.600	
29	6761	564.025		29	6813	565.325		30	6865	566.625	
29	6762	564.050		29	6814	565.350		30	6866	566.650	
29	6763	564.075		29	6815	565.375		30	6867	566.675	
29	6764	564.100		29	6816	565.400		30	6868	566.700	
29	6765	564.125		29	6817	565.425		30	6869	566.725	
29	6766	564.150		29	6818	565.450		30	6870	566.750	
29	6767	564.175		29	6819	565.475		30	6871	566.775	
29	6768	564.200		29	6820	565.500		30	6872	566.800	
29	6769	564.225		29	6821	565.525		30	6873	566.825	
29	6770	564.250		29	6822	565.550		30	6874	566.850	
29	6771	564.275		29	6823	565.575		30	6875	566.875	
29	6772	564.300		29	6824	565.600		30	6876	566.900	
29	6773	564.325		29	6825	565.625		30	6877	566.925	
29	6774	564.350		29	6826	565.650		30	6878	566.950	
29	6775	564.375		29	6827	565.675		30	6879	566.975	
29	6776	564.400		29	6828	565.700		30	6880	567.000	
29	6777	564.425		29	6829	565.725		30	6881	567.025	
29	6778	564.450		29	6830	565.750		30	6882	567.050	
29	6779	564.475		29	6831	565.775		30	6883	567.075	
29	6780	564.500		29	6832	565.800		30	6884	567.100	
29	6781	564.525		29	6833	565.825		30	6885	567.125	
29	6782	564.550		29	6834	565.850		30	6886	567.150	
29	6783	564.575		29	6835	565.875		30	6887	567.175	
29	6784	564.600	Reserved	29	6836	565.900		30	6888	567.200	Reserved
29	6785	564.625		29	6837	565.925		30	6889	567.225	
29	6786	564.650		29	6838	565.950		30	6890	567.250	
29	6787	564.675		29	6839	565.975		30	6891	567.275	
29	6788	564.700		30	6840	566.000		30	6892	567.300	
29	6789	564.725		30	6841	566.025		30	6893	567.325	
29	6790	564.750		30	6842	566.050		30	6894	567.350	
29	6791	564.775		30	6843	566.075		30	6895	567.375	
29	6792	564.800		30	6844	566.100		30	6896	567.400	
29	6793	564.825		30	6845	566.125		30	6897	567.425	
29	6794	564.850		30	6846	566.150		30	6898	567.450	
29	6795	564.875		30	6847	566.175		30	6899	567.475	
29	6796	564.900		30	6848	566.200		30	6900	567.500	
29	6797	564.925		30	6849	566.225		30	6901	567.525	
29	6798	564.950		30	6850	566.250		30	6902	567.550	
29	6799	564.975		30	6851	566.275		30	6903	567.575	
29	6800	565.000		30	6852	566.300		30	6904	567.600	
29	6801	565.025		30	6853	566.325		30	6905	567.625	

30	6906	567.650		30	6958	568.950		30	7010	570.250	
30	6907	567.675		30	6959	568.975		30	7011	570.275	
30	6908	567.700		30	6960	569.000		30	7012	570.300	
30	6909	567.725		30	6961	569.025		30	7013	570.325	
30	6910	567.750		30	6962	569.050		30	7014	570.350	
30	6911	567.775		30	6963	569.075		30	7015	570.375	
30	6912	567.800		30	6964	569.100		30	7016	570.400	
30	6913	567.825		30	6965	569.125		30	7017	570.425	
30	6914	567.850		30	6966	569.150		30	7018	570.450	
30	6915	567.875		30	6967	569.175		30	7019	570.475	
30	6916	567.900		30	6968	569.200		30	7020	570.500	
30	6917	567.925		30	6969	569.225		30	7021	570.525	
30	6918	567.950		30	6970	569.250		30	7022	570.550	
30	6919	567.975		30	6971	569.275		30	7023	570.575	
30	6920	568.000		30	6972	569.300		30	7024	570.600	
30	6921	568.025		30	6973	569.325		30	7025	570.625	
30	6922	568.050		30	6974	569.350		30	7026	570.650	
30	6923	568.075		30	6975	569.375		30	7027	570.675	
30	6924	568.100		30	6976	569.400		30	7028	570.700	
30	6925	568.125		30	6977	569.425		30	7029	570.725	
30	6926	568.150		30	6978	569.450		30	7030	570.750	
30	6927	568.175		30	6979	569.475		30	7031	570.775	
30	6928	568.200		30	6980	569.500		30	7032	570.800	
30	6929	568.225		30	6981	569.525		30	7033	570.825	
30	6930	568.250		30	6982	569.550		30	7034	570.850	
30	6931	568.275		30	6983	569.575		30	7035	570.875	
30	6932	568.300		30	6984	569.600		30	7036	570.900	
30	6933	568.325		30	6985	569.625		30	7037	570.925	
30	6934	568.350		30	6986	569.650		30	7038	570.950	
30	6935	568.375		30	6987	569.675		30	7039	570.975	
30	6936	568.400		30	6988	569.700		30	7040	571.000	
30	6937	568.425		30	6989	569.725		30	7041	571.025	
30	6938	568.450		30	6990	569.750		30	7042	571.050	
30	6939	568.475		30	6991	569.775		30	7043	571.075	
30	6940	568.500		30	6992	569.800		30	7044	571.100	
30	6941	568.525		30	6993	569.825		30	7045	571.125	
30	6942	568.550		30	6994	569.850		30	7046	571.150	
30	6943	568.575		30	6995	569.875		30	7047	571.175	
30	6944	568.600		30	6996	569.900		30	7048	571.200	
30	6945	568.625		30	6997	569.925		30	7049	571.225	
30	6946	568.650		30	6998	569.950		30	7050	571.250	
30	6947	568.675		30	6999	569.975		30	7051	571.275	
30	6948	568.700		30	7000	570.000	Reserved	30	7052	571.300	
30	6949	568.725		30	7001	570.025		30	7053	571.325	
30	6950	568.750		30	7002	570.050		30	7054	571.350	
30	6951	568.775		30	7003	570.075		30	7055	571.375	
30	6952	568.800		30	7004	570.100		30	7056	571.400	
30	6953	568.825		30	7005	570.125		30	7057	571.425	
30	6954	568.850		30	7006	570.150		30	7058	571.450	
30	6955	568.875		30	7007	570.175		30	7059	571.475	
30	6956	568.900		30	7008	570.200		30	7060	571.500	
30	6957	568.925		30	7009	570.225		30	7061	571.525	

30	7062	571.550		31	7114	572.850		31	7166	574.150	
30	7063	571.575		31	7115	572.875		31	7167	574.175	
30	7064	571.600		31	7116	572.900		31	7168	574.200	
30	7065	571.625		31	7117	572.925		31	7169	574.225	
30	7066	571.650		31	7118	572.950		31	7170	574.250	
30	7067	571.675		31	7119	572.975		31	7171	574.275	
30	7068	571.700	Reserved	31	7120	573.000		31	7172	574.300	
30	7069	571.725		31	7121	573.025		31	7173	574.325	
30	7070	571.750		31	7122	573.050		31	7174	574.350	
30	7071	571.775		31	7123	573.075		31	7175	574.375	
30	7072	571.800		31	7124	573.100		31	7176	574.400	
30	7073	571.825		31	7125	573.125		31	7177	574.425	
30	7074	571.850		31	7126	573.150		31	7178	574.450	
30	7075	571.875		31	7127	573.175		31	7179	574.475	
30	7076	571.900		31	7128	573.200		31	7180	574.500	
30	7077	571.925		31	7129	573.225		31	7181	574.525	
30	7078	571.950		31	7130	573.250		31	7182	574.550	
30	7079	571.975		31	7131	573.275		31	7183	574.575	
31	7080	572.000		31	7132	573.300		31	7184	574.600	
31	7081	572.025		31	7133	573.325		31	7185	574.625	
31	7082	572.050		31	7134	573.350		31	7186	574.650	
31	7083	572.075		31	7135	573.375		31	7187	574.675	
31	7084	572.100		31	7136	573.400		31	7188	574.700	
31	7085	572.125		31	7137	573.425		31	7189	574.725	
31	7086	572.150		31	7138	573.450		31	7190	574.750	
31	7087	572.175		31	7139	573.475		31	7191	574.775	
31	7088	572.200		31	7140	573.500		31	7192	574.800	
31	7089	572.225		31	7141	573.525		31	7193	574.825	
31	7090	572.250		31	7142	573.550		31	7194	574.850	
31	7091	572.275		31	7143	573.575		31	7195	574.875	
31	7092	572.300		31	7144	573.600		31	7196	574.900	
31	7093	572.325		31	7145	573.625		31	7197	574.925	
31	7094	572.350		31	7146	573.650		31	7198	574.950	
31	7095	572.375		31	7147	573.675		31	7199	574.975	
31	7096	572.400		31	7148	573.700		31	7200	575.000	
31	7097	572.425		31	7149	573.725		31	7201	575.025	
31	7098	572.450		31	7150	573.750		31	7202	575.050	
31	7099	572.475		31	7151	573.775		31	7203	575.075	
31	7100	572.500		31	7152	573.800		31	7204	575.100	
31	7101	572.525		31	7153	573.825		31	7205	575.125	
31	7102	572.550		31	7154	573.850		31	7206	575.150	
31	7103	572.575		31	7155	573.875		31	7207	575.175	
31	7104	572.600		31	7156	573.900		31	7208	575.200	
31	7105	572.625		31	7157	573.925		31	7209	575.225	
31	7106	572.650		31	7158	573.950		31	7210	575.250	
31	7107	572.675		31	7159	573.975		31	7211	575.275	
31	7108	572.700		31	7160	574.000		31	7212	575.300	
31	7109	572.725		31	7161	574.025		31	7213	575.325	
31	7110	572.750		31	7162	574.050		31	7214	575.350	
31	7111	572.775		31	7163	574.075		31	7215	575.375	
31	7112	572.800		31	7164	574.100		31	7216	575.400	
31	7113	572.825		31	7165	574.125		31	7217	575.425	

31	7218	575.450		31	7270	576.750	Reserved	32	7322	578.050	
31	7219	575.475		31	7271	576.775		32	7323	578.075	
31	7220	575.500		31	7272	576.800		32	7324	578.100	
31	7221	575.525		31	7273	576.825		32	7325	578.125	
31	7222	575.550		31	7274	576.850		32	7326	578.150	
31	7223	575.575		31	7275	576.875		32	7327	578.175	
31	7224	575.600		31	7276	576.900		32	7328	578.200	
31	7225	575.625		31	7277	576.925		32	7329	578.225	
31	7226	575.650		31	7278	576.950		32	7330	578.250	
31	7227	575.675		31	7279	576.975		32	7331	578.275	
31	7228	575.700		31	7280	577.000		32	7332	578.300	
31	7229	575.725		31	7281	577.025		32	7333	578.325	
31	7230	575.750		31	7282	577.050		32	7334	578.350	
31	7231	575.775		31	7283	577.075		32	7335	578.375	
31	7232	575.800		31	7284	577.100		32	7336	578.400	
31	7233	575.825		31	7285	577.125		32	7337	578.425	
31	7234	575.850		31	7286	577.150		32	7338	578.450	
31	7235	575.875		31	7287	577.175		32	7339	578.475	
31	7236	575.900		31	7288	577.200		32	7340	578.500	
31	7237	575.925		31	7289	577.225		32	7341	578.525	
31	7238	575.950		31	7290	577.250		32	7342	578.550	
31	7239	575.975		31	7291	577.275		32	7343	578.575	
31	7240	576.000	Reserved	31	7292	577.300		32	7344	578.600	
31	7241	576.025		31	7293	577.325		32	7345	578.625	
31	7242	576.050		31	7294	577.350		32	7346	578.650	
31	7243	576.075		31	7295	577.375		32	7347	578.675	
31	7244	576.100		31	7296	577.400		32	7348	578.700	
31	7245	576.125		31	7297	577.425		32	7349	578.725	
31	7246	576.150		31	7298	577.450		32	7350	578.750	
31	7247	576.175		31	7299	577.475		32	7351	578.775	
31	7248	576.200		31	7300	577.500		32	7352	578.800	
31	7249	576.225		31	7301	577.525		32	7353	578.825	
31	7250	576.250		31	7302	577.550		32	7354	578.850	
31	7251	576.275		31	7303	577.575		32	7355	578.875	
31	7252	576.300		31	7304	577.600		32	7356	578.900	
31	7253	576.325		31	7305	577.625		32	7357	578.925	
31	7254	576.350		31	7306	577.650		32	7358	578.950	
31	7255	576.375		31	7307	577.675		32	7359	578.975	
31	7256	576.400		31	7308	577.700		32	7360	579.000	
31	7257	576.425		31	7309	577.725		32	7361	579.025	
31	7258	576.450		31	7310	577.750		32	7362	579.050	
31	7259	576.475		31	7311	577.775		32	7363	579.075	
31	7260	576.500		31	7312	577.800		32	7364	579.100	
31	7261	576.525		31	7313	577.825		32	7365	579.125	
31	7262	576.550		31	7314	577.850		32	7366	579.150	
31	7263	576.575		31	7315	577.875		32	7367	579.175	
31	7264	576.600		31	7316	577.900		32	7368	579.200	
31	7265	576.625		31	7317	577.925		32	7369	579.225	
31	7266	576.650		31	7318	577.950		32	7370	579.250	
31	7267	576.675		31	7319	577.975		32	7371	579.275	
31	7268	576.700		32	7320	578.000		32	7372	579.300	
31	7269	576.725		32	7321	578.025		32	7373	579.325	

32	7374	579.350		32	7426	580.650		32	7478	581.950	
32	7375	579.375		32	7427	580.675		32	7479	581.975	
32	7376	579.400		32	7428	580.700		32	7480	582.000	
32	7377	579.425		32	7429	580.725		32	7481	582.025	
32	7378	579.450		32	7430	580.750		32	7482	582.050	
32	7379	579.475		32	7431	580.775		32	7483	582.075	
32	7380	579.500		32	7432	580.800		32	7484	582.100	
32	7381	579.525		32	7433	580.825		32	7485	582.125	
32	7382	579.550		32	7434	580.850		32	7486	582.150	
32	7383	579.575		32	7435	580.875		32	7487	582.175	
32	7384	579.600		32	7436	580.900		32	7488	582.200	
32	7385	579.625		32	7437	580.925		32	7489	582.225	
32	7386	579.650		32	7438	580.950		32	7490	582.250	
32	7387	579.675		32	7439	580.975		32	7491	582.275	
32	7388	579.700		32	7440	581.000		32	7492	582.300	
32	7389	579.725		32	7441	581.025		32	7493	582.325	
32	7390	579.750		32	7442	581.050		32	7494	582.350	
32	7391	579.775		32	7443	581.075		32	7495	582.375	
32	7392	579.800		32	7444	581.100		32	7496	582.400	
32	7393	579.825		32	7445	581.125		32	7497	582.425	
32	7394	579.850		32	7446	581.150		32	7498	582.450	
32	7395	579.875		32	7447	581.175		32	7499	582.475	
32	7396	579.900		32	7448	581.200		32	7500	582.500	
32	7397	579.925		32	7449	581.225		32	7501	582.525	
32	7398	579.950		32	7450	581.250		32	7502	582.550	
32	7399	579.975		32	7451	581.275		32	7503	582.575	
32	7400	580.000	Reserved	32	7452	581.300		32	7504	582.600	
32	7401	580.025		32	7453	581.325		32	7505	582.625	
32	7402	580.050		32	7454	581.350		32	7506	582.650	
32	7403	580.075		32	7455	581.375		32	7507	582.675	
32	7404	580.100		32	7456	581.400		32	7508	582.700	
32	7405	580.125		32	7457	581.425		32	7509	582.725	
32	7406	580.150		32	7458	581.450		32	7510	582.750	
32	7407	580.175		32	7459	581.475		32	7511	582.775	
32	7408	580.200		32	7460	581.500		32	7512	582.800	
32	7409	580.225		32	7461	581.525		32	7513	582.825	
32	7410	580.250		32	7462	581.550		32	7514	582.850	
32	7411	580.275		32	7463	581.575		32	7515	582.875	
32	7412	580.300		32	7464	581.600		32	7516	582.900	
32	7413	580.325		32	7465	581.625		32	7517	582.925	
32	7414	580.350		32	7466	581.650		32	7518	582.950	
32	7415	580.375		32	7467	581.675		32	7519	582.975	
32	7416	580.400		32	7468	581.700		32	7520	583.000	
32	7417	580.425		32	7469	581.725		32	7521	583.025	
32	7418	580.450		32	7470	581.750		32	7522	583.050	
32	7419	580.475		32	7471	581.775		32	7523	583.075	
32	7420	580.500		32	7472	581.800		32	7524	583.100	
32	7421	580.525		32	7473	581.825		32	7525	583.125	
32	7422	580.550		32	7474	581.850		32	7526	583.150	
32	7423	580.575		32	7475	581.875		32	7527	583.175	
32	7424	580.600		32	7476	581.900		32	7528	583.200	
32	7425	580.625		32	7477	581.925		32	7529	583.225	

32	7530	583.250		33	7582	584.550		33	7634	585.850	
32	7531	583.275		33	7583	584.575		33	7635	585.875	
32	7532	583.300		33	7584	584.600		33	7636	585.900	
32	7533	583.325		33	7585	584.625		33	7637	585.925	
32	7534	583.350		33	7586	584.650		33	7638	585.950	
32	7535	583.375		33	7587	584.675		33	7639	585.975	
32	7536	583.400		33	7588	584.700		33	7640	586.000	
32	7537	583.425		33	7589	584.725		33	7641	586.025	
32	7538	583.450		33	7590	584.750		33	7642	586.050	
32	7539	583.475		33	7591	584.775		33	7643	586.075	
32	7540	583.500		33	7592	584.800		33	7644	586.100	
32	7541	583.525		33	7593	584.825		33	7645	586.125	
32	7542	583.550		33	7594	584.850		33	7646	586.150	
32	7543	583.575		33	7595	584.875		33	7647	586.175	
32	7544	583.600		33	7596	584.900		33	7648	586.200	
32	7545	583.625		33	7597	584.925		33	7649	586.225	
32	7546	583.650		33	7598	584.950		33	7650	586.250	
32	7547	583.675		33	7599	584.975		33	7651	586.275	
32	7548	583.700		33	7600	585.000		33	7652	586.300	
32	7549	583.725		33	7601	585.025		33	7653	586.325	
32	7550	583.750		33	7602	585.050		33	7654	586.350	
32	7551	583.775		33	7603	585.075		33	7655	586.375	
32	7552	583.800		33	7604	585.100		33	7656	586.400	
32	7553	583.825		33	7605	585.125		33	7657	586.425	
32	7554	583.850		33	7606	585.150		33	7658	586.450	
32	7555	583.875		33	7607	585.175		33	7659	586.475	
32	7556	583.900		33	7608	585.200		33	7660	586.500	
32	7557	583.925		33	7609	585.225		33	7661	586.525	
32	7558	583.950		33	7610	585.250		33	7662	586.550	
32	7559	583.975		33	7611	585.275		33	7663	586.575	
33	7560	584.000		33	7612	585.300		33	7664	586.600	
33	7561	584.025		33	7613	585.325		33	7665	586.625	
33	7562	584.050		33	7614	585.350		33	7666	586.650	
33	7563	584.075		33	7615	585.375		33	7667	586.675	
33	7564	584.100		33	7616	585.400		33	7668	586.700	
33	7565	584.125		33	7617	585.425		33	7669	586.725	
33	7566	584.150		33	7618	585.450		33	7670	586.750	
33	7567	584.175		33	7619	585.475		33	7671	586.775	
33	7568	584.200		33	7620	585.500		33	7672	586.800	
33	7569	584.225		33	7621	585.525		33	7673	586.825	
33	7570	584.250		33	7622	585.550		33	7674	586.850	
33	7571	584.275		33	7623	585.575		33	7675	586.875	
33	7572	584.300		33	7624	585.600		33	7676	586.900	
33	7573	584.325		33	7625	585.625		33	7677	586.925	
33	7574	584.350		33	7626	585.650		33	7678	586.950	
33	7575	584.375		33	7627	585.675		33	7679	586.975	
33	7576	584.400		33	7628	585.700		33	7680	587.000	
33	7577	584.425		33	7629	585.725		33	7681	587.025	
33	7578	584.450		33	7630	585.750		33	7682	587.050	
33	7579	584.475		33	7631	585.775		33	7683	587.075	
33	7580	584.500		33	7632	585.800		33	7684	587.100	
33	7581	584.525		33	7633	585.825		33	7685	587.125	

33	7686	587.150		33	7738	588.450		33	7790	589.750	
33	7687	587.175		33	7739	588.475		33	7791	589.775	
33	7688	587.200		33	7740	588.500		33	7792	589.800	
33	7689	587.225		33	7741	588.525		33	7793	589.825	
33	7690	587.250		33	7742	588.550		33	7794	589.850	
33	7691	587.275		33	7743	588.575		33	7795	589.875	
33	7692	587.300		33	7744	588.600		33	7796	589.900	
33	7693	587.325		33	7745	588.625		33	7797	589.925	
33	7694	587.350		33	7746	588.650		33	7798	589.950	
33	7695	587.375		33	7747	588.675		33	7799	589.975	
33	7696	587.400		33	7748	588.700		34	7800	590.000	Reserved
33	7697	587.425		33	7749	588.725		34	7801	590.025	
33	7698	587.450		33	7750	588.750		34	7802	590.050	
33	7699	587.475		33	7751	588.775		34	7803	590.075	
33	7700	587.500		33	7752	588.800		34	7804	590.100	
33	7701	587.525		33	7753	588.825		34	7805	590.125	
33	7702	587.550		33	7754	588.850		34	7806	590.150	
33	7703	587.575		33	7755	588.875		34	7807	590.175	
33	7704	587.600		33	7756	588.900		34	7808	590.200	
33	7705	587.625		33	7757	588.925		34	7809	590.225	
33	7706	587.650		33	7758	588.950		34	7810	590.250	
33	7707	587.675		33	7759	588.975		34	7811	590.275	
33	7708	587.700		33	7760	589.000		34	7812	590.300	
33	7709	587.725		33	7761	589.025		34	7813	590.325	
33	7710	587.750		33	7762	589.050		34	7814	590.350	
33	7711	587.775		33	7763	589.075		34	7815	590.375	
33	7712	587.800		33	7764	589.100		34	7816	590.400	Reserved
33	7713	587.825		33	7765	589.125		34	7817	590.425	
33	7714	587.850		33	7766	589.150		34	7818	590.450	
33	7715	587.875		33	7767	589.175		34	7819	590.475	
33	7716	587.900		33	7768	589.200		34	7820	590.500	
33	7717	587.925		33	7769	589.225		34	7821	590.525	
33	7718	587.950		33	7770	589.250		34	7822	590.550	
33	7719	587.975		33	7771	589.275		34	7823	590.575	
33	7720	588.000		33	7772	589.300		34	7824	590.600	
33	7721	588.025		33	7773	589.325		34	7825	590.625	
33	7722	588.050		33	7774	589.350		34	7826	590.650	
33	7723	588.075		33	7775	589.375		34	7827	590.675	
33	7724	588.100		33	7776	589.400		34	7828	590.700	
33	7725	588.125		33	7777	589.425		34	7829	590.725	
33	7726	588.150		33	7778	589.450		34	7830	590.750	
33	7727	588.175		33	7779	589.475		34	7831	590.775	
33	7728	588.200		33	7780	589.500		34	7832	590.800	
33	7729	588.225		33	7781	589.525		34	7833	590.825	
33	7730	588.250		33	7782	589.550		34	7834	590.850	
33	7731	588.275		33	7783	589.575		34	7835	590.875	
33	7732	588.300		33	7784	589.600		34	7836	590.900	
33	7733	588.325		33	7785	589.625		34	7837	590.925	
33	7734	588.350		33	7786	589.650		34	7838	590.950	
33	7735	588.375		33	7787	589.675		34	7839	590.975	
33	7736	588.400		33	7788	589.700		34	7840	591.000	
33	7737	588.425		33	7789	589.725		34	7841	591.025	

34	7842	591.050		34	7894	592.350		34	7946	593.650	
34	7843	591.075		34	7895	592.375		34	7947	593.675	
34	7844	591.100		34	7896	592.400		34	7948	593.700	
34	7845	591.125		34	7897	592.425		34	7949	593.725	
34	7846	591.150		34	7898	592.450		34	7950	593.750	
34	7847	591.175		34	7899	592.475		34	7951	593.775	
34	7848	591.200		34	7900	592.500		34	7952	593.800	
34	7849	591.225		34	7901	592.525		34	7953	593.825	
34	7850	591.250		34	7902	592.550		34	7954	593.850	
34	7851	591.275		34	7903	592.575		34	7955	593.875	
34	7852	591.300		34	7904	592.600		34	7956	593.900	
34	7853	591.325		34	7905	592.625		34	7957	593.925	
34	7854	591.350		34	7906	592.650		34	7958	593.950	
34	7855	591.375		34	7907	592.675		34	7959	593.975	
34	7856	591.400		34	7908	592.700		34	7960	594.000	
34	7857	591.425		34	7909	592.725		34	7961	594.025	
34	7858	591.450		34	7910	592.750		34	7962	594.050	
34	7859	591.475		34	7911	592.775		34	7963	594.075	
34	7860	591.500		34	7912	592.800		34	7964	594.100	
34	7861	591.525		34	7913	592.825		34	7965	594.125	
34	7862	591.550		34	7914	592.850		34	7966	594.150	
34	7863	591.575		34	7915	592.875		34	7967	594.175	
34	7864	591.600		34	7916	592.900		34	7968	594.200	
34	7865	591.625		34	7917	592.925		34	7969	594.225	
34	7866	591.650		34	7918	592.950		34	7970	594.250	
34	7867	591.675		34	7919	592.975		34	7971	594.275	
34	7868	591.700		34	7920	593.000		34	7972	594.300	
34	7869	591.725		34	7921	593.025		34	7973	594.325	
34	7870	591.750		34	7922	593.050		34	7974	594.350	
34	7871	591.775		34	7923	593.075		34	7975	594.375	
34	7872	591.800		34	7924	593.100		34	7976	594.400	
34	7873	591.825		34	7925	593.125		34	7977	594.425	
34	7874	591.850		34	7926	593.150		34	7978	594.450	
34	7875	591.875		34	7927	593.175		34	7979	594.475	
34	7876	591.900		34	7928	593.200		34	7980	594.500	
34	7877	591.925		34	7929	593.225		34	7981	594.525	
34	7878	591.950		34	7930	593.250		34	7982	594.550	
34	7879	591.975		34	7931	593.275		34	7983	594.575	
34	7880	592.000		34	7932	593.300		34	7984	594.600	
34	7881	592.025		34	7933	593.325		34	7985	594.625	
34	7882	592.050		34	7934	593.350		34	7986	594.650	
34	7883	592.075		34	7935	593.375		34	7987	594.675	
34	7884	592.100		34	7936	593.400		34	7988	594.700	
34	7885	592.125		34	7937	593.425		34	7989	594.725	
34	7886	592.150		34	7938	593.450		34	7990	594.750	
34	7887	592.175		34	7939	593.475		34	7991	594.775	
34	7888	592.200		34	7940	593.500		34	7992	594.800	
34	7889	592.225		34	7941	593.525		34	7993	594.825	
34	7890	592.250		34	7942	593.550		34	7994	594.850	
34	7891	592.275		34	7943	593.575		34	7995	594.875	
34	7892	592.300		34	7944	593.600		34	7996	594.900	
34	7893	592.325		34	7945	593.625		34	7997	594.925	

34	7998	594.950		35	8050	596.250		35	8102	597.550	
34	7999	594.975		35	8051	596.275		35	8103	597.575	
34	8000	595.000		35	8052	596.300		35	8104	597.600	
34	8001	595.025		35	8053	596.325		35	8105	597.625	
34	8002	595.050		35	8054	596.350		35	8106	597.650	
34	8003	595.075		35	8055	596.375		35	8107	597.675	
34	8004	595.100		35	8056	596.400		35	8108	597.700	
34	8005	595.125		35	8057	596.425		35	8109	597.725	
34	8006	595.150		35	8058	596.450		35	8110	597.750	
34	8007	595.175		35	8059	596.475		35	8111	597.775	
34	8008	595.200		35	8060	596.500		35	8112	597.800	
34	8009	595.225		35	8061	596.525		35	8113	597.825	
34	8010	595.250		35	8062	596.550		35	8114	597.850	
34	8011	595.275		35	8063	596.575		35	8115	597.875	
34	8012	595.300		35	8064	596.600		35	8116	597.900	
34	8013	595.325		35	8065	596.625		35	8117	597.925	
34	8014	595.350		35	8066	596.650		35	8118	597.950	
34	8015	595.375		35	8067	596.675		35	8119	597.975	
34	8016	595.400		35	8068	596.700		35	8120	598.000	
34	8017	595.425		35	8069	596.725		35	8121	598.025	
34	8018	595.450		35	8070	596.750		35	8122	598.050	
34	8019	595.475		35	8071	596.775		35	8123	598.075	
34	8020	595.500		35	8072	596.800		35	8124	598.100	
34	8021	595.525		35	8073	596.825		35	8125	598.125	
34	8022	595.550		35	8074	596.850		35	8126	598.150	
34	8023	595.575		35	8075	596.875		35	8127	598.175	
34	8024	595.600		35	8076	596.900		35	8128	598.200	
34	8025	595.625		35	8077	596.925		35	8129	598.225	
34	8026	595.650		35	8078	596.950		35	8130	598.250	
34	8027	595.675		35	8079	596.975		35	8131	598.275	
34	8028	595.700		35	8080	597.000		35	8132	598.300	
34	8029	595.725		35	8081	597.025		35	8133	598.325	
34	8030	595.750		35	8082	597.050		35	8134	598.350	
34	8031	595.775		35	8083	597.075		35	8135	598.375	
34	8032	595.800		35	8084	597.100		35	8136	598.400	
34	8033	595.825		35	8085	597.125		35	8137	598.425	
34	8034	595.850		35	8086	597.150		35	8138	598.450	
34	8035	595.875		35	8087	597.175		35	8139	598.475	
34	8036	595.900		35	8088	597.200		35	8140	598.500	
34	8037	595.925		35	8089	597.225		35	8141	598.525	
34	8038	595.950		35	8090	597.250		35	8142	598.550	
34	8039	595.975		35	8091	597.275		35	8143	598.575	
35	8040	596.000		35	8092	597.300		35	8144	598.600	
35	8041	596.025		35	8093	597.325		35	8145	598.625	
35	8042	596.050		35	8094	597.350		35	8146	598.650	
35	8043	596.075		35	8095	597.375		35	8147	598.675	
35	8044	596.100		35	8096	597.400		35	8148	598.700	
35	8045	596.125		35	8097	597.425		35	8149	598.725	
35	8046	596.150		35	8098	597.450		35	8150	598.750	
35	8047	596.175		35	8099	597.475		35	8151	598.775	
35	8048	596.200		35	8100	597.500		35	8152	598.800	
35	8049	596.225		35	8101	597.525		35	8153	598.825	

35	8154	598.850		35	8206	600.150		35	8258	601.450	
35	8155	598.875		35	8207	600.175		35	8259	601.475	
35	8156	598.900		35	8208	600.200		35	8260	601.500	
35	8157	598.925		35	8209	600.225		35	8261	601.525	
35	8158	598.950		35	8210	600.250		35	8262	601.550	
35	8159	598.975		35	8211	600.275		35	8263	601.575	
35	8160	599.000		35	8212	600.300		35	8264	601.600	
35	8161	599.025		35	8213	600.325		35	8265	601.625	
35	8162	599.050		35	8214	600.350		35	8266	601.650	
35	8163	599.075		35	8215	600.375		35	8267	601.675	
35	8164	599.100		35	8216	600.400		35	8268	601.700	
35	8165	599.125		35	8217	600.425		35	8269	601.725	
35	8166	599.150		35	8218	600.450		35	8270	601.750	
35	8167	599.175		35	8219	600.475		35	8271	601.775	
35	8168	599.200		35	8220	600.500		35	8272	601.800	
35	8169	599.225		35	8221	600.525		35	8273	601.825	
35	8170	599.250		35	8222	600.550		35	8274	601.850	
35	8171	599.275		35	8223	600.575		35	8275	601.875	
35	8172	599.300		35	8224	600.600		35	8276	601.900	
35	8173	599.325		35	8225	600.625		35	8277	601.925	
35	8174	599.350		35	8226	600.650		35	8278	601.950	
35	8175	599.375		35	8227	600.675		35	8279	601.975	
35	8176	599.400		35	8228	600.700		36	8280	602.000	
35	8177	599.425		35	8229	600.725		36	8281	602.025	
35	8178	599.450		35	8230	600.750		36	8282	602.050	
35	8179	599.475		35	8231	600.775		36	8283	602.075	
35	8180	599.500		35	8232	600.800		36	8284	602.100	
35	8181	599.525		35	8233	600.825		36	8285	602.125	
35	8182	599.550		35	8234	600.850		36	8286	602.150	
35	8183	599.575		35	8235	600.875		36	8287	602.175	
35	8184	599.600		35	8236	600.900		36	8288	602.200	
35	8185	599.625		35	8237	600.925		36	8289	602.225	
35	8186	599.650		35	8238	600.950		36	8290	602.250	
35	8187	599.675		35	8239	600.975		36	8291	602.275	
35	8188	599.700		35	8240	601.000		36	8292	602.300	
35	8189	599.725		35	8241	601.025		36	8293	602.325	
35	8190	599.750		35	8242	601.050		36	8294	602.350	
35	8191	599.775		35	8243	601.075		36	8295	602.375	
35	8192	599.800		35	8244	601.100		36	8296	602.400	
35	8193	599.825		35	8245	601.125		36	8297	602.425	
35	8194	599.850		35	8246	601.150		36	8298	602.450	
35	8195	599.875		35	8247	601.175		36	8299	602.475	
35	8196	599.900		35	8248	601.200		36	8300	602.500	
35	8197	599.925		35	8249	601.225		36	8301	602.525	
35	8198	599.950		35	8250	601.250		36	8302	602.550	
35	8199	599.975		35	8251	601.275		36	8303	602.575	
35	8200	600.000	Reserved	35	8252	601.300		36	8304	602.600	
35	8201	600.025		35	8253	601.325		36	8305	602.625	
35	8202	600.050		35	8254	601.350		36	8306	602.650	
35	8203	600.075		35	8255	601.375		36	8307	602.675	
35	8204	600.100		35	8256	601.400		36	8308	602.700	
35	8205	600.125		35	8257	601.425		36	8309	602.725	

36	8310	602.750		36	8362	604.050		36	8414	605.350	
36	8311	602.775		36	8363	604.075		36	8415	605.375	
36	8312	602.800		36	8364	604.100		36	8416	605.400	
36	8313	602.825		36	8365	604.125		36	8417	605.425	
36	8314	602.850		36	8366	604.150		36	8418	605.450	
36	8315	602.875		36	8367	604.175		36	8419	605.475	
36	8316	602.900		36	8368	604.200		36	8420	605.500	
36	8317	602.925		36	8369	604.225		36	8421	605.525	
36	8318	602.950		36	8370	604.250		36	8422	605.550	
36	8319	602.975		36	8371	604.275		36	8423	605.575	
36	8320	603.000		36	8372	604.300		36	8424	605.600	
36	8321	603.025		36	8373	604.325		36	8425	605.625	
36	8322	603.050		36	8374	604.350		36	8426	605.650	
36	8323	603.075		36	8375	604.375		36	8427	605.675	
36	8324	603.100		36	8376	604.400		36	8428	605.700	
36	8325	603.125		36	8377	604.425		36	8429	605.725	
36	8326	603.150		36	8378	604.450		36	8430	605.750	
36	8327	603.175		36	8379	604.475		36	8431	605.775	
36	8328	603.200	Reserved	36	8380	604.500		36	8432	605.800	
36	8329	603.225		36	8381	604.525		36	8433	605.825	
36	8330	603.250		36	8382	604.550		36	8434	605.850	
36	8331	603.275		36	8383	604.575		36	8435	605.875	
36	8332	603.300		36	8384	604.600		36	8436	605.900	
36	8333	603.325		36	8385	604.625		36	8437	605.925	
36	8334	603.350		36	8386	604.650		36	8438	605.950	
36	8335	603.375		36	8387	604.675		36	8439	605.975	
36	8336	603.400		36	8388	604.700		36	8440	606.000	
36	8337	603.425		36	8389	604.725		36	8441	606.025	
36	8338	603.450		36	8390	604.750		36	8442	606.050	
36	8339	603.475		36	8391	604.775		36	8443	606.075	
36	8340	603.500		36	8392	604.800	Reserved	36	8444	606.100	
36	8341	603.525		36	8393	604.825		36	8445	606.125	
36	8342	603.550		36	8394	604.850		36	8446	606.150	
36	8343	603.575		36	8395	604.875		36	8447	606.175	
36	8344	603.600		36	8396	604.900		36	8448	606.200	
36	8345	603.625		36	8397	604.925		36	8449	606.225	
36	8346	603.650		36	8398	604.950		36	8450	606.250	
36	8347	603.675		36	8399	604.975		36	8451	606.275	
36	8348	603.700		36	8400	605.000		36	8452	606.300	
36	8349	603.725		36	8401	605.025		36	8453	606.325	
36	8350	603.750		36	8402	605.050		36	8454	606.350	
36	8351	603.775		36	8403	605.075		36	8455	606.375	
36	8352	603.800		36	8404	605.100		36	8456	606.400	
36	8353	603.825		36	8405	605.125		36	8457	606.425	
36	8354	603.850		36	8406	605.150		36	8458	606.450	
36	8355	603.875		36	8407	605.175		36	8459	606.475	
36	8356	603.900		36	8408	605.200		36	8460	606.500	
36	8357	603.925		36	8409	605.225		36	8461	606.525	
36	8358	603.950		36	8410	605.250		36	8462	606.550	
36	8359	603.975		36	8411	605.275		36	8463	606.575	
36	8360	604.000		36	8412	605.300		36	8464	606.600	
36	8361	604.025		36	8413	605.325		36	8465	606.625	

36	8466	606.650		36	8518	607.950		37	8570	609.250	
36	8467	606.675		36	8519	607.975		37	8571	609.275	
36	8468	606.700		37	8520	608.000		37	8572	609.300	
36	8469	606.725		37	8521	608.025		37	8573	609.325	
36	8470	606.750		37	8522	608.050		37	8574	609.350	
36	8471	606.775		37	8523	608.075		37	8575	609.375	
36	8472	606.800		37	8524	608.100		37	8576	609.400	
36	8473	606.825		37	8525	608.125		37	8577	609.425	
36	8474	606.850		37	8526	608.150		37	8578	609.450	
36	8475	606.875		37	8527	608.175		37	8579	609.475	
36	8476	606.900		37	8528	608.200		37	8580	609.500	
36	8477	606.925		37	8529	608.225		37	8581	609.525	
36	8478	606.950		37	8530	608.250		37	8582	609.550	
36	8479	606.975		37	8531	608.275		37	8583	609.575	
36	8480	607.000		37	8532	608.300		37	8584	609.600	
36	8481	607.025		37	8533	608.325		37	8585	609.625	
36	8482	607.050		37	8534	608.350		37	8586	609.650	
36	8483	607.075		37	8535	608.375		37	8587	609.675	
36	8484	607.100		37	8536	608.400		37	8588	609.700	
36	8485	607.125		37	8537	608.425		37	8589	609.725	
36	8486	607.150		37	8538	608.450		37	8590	609.750	
36	8487	607.175		37	8539	608.475		37	8591	609.775	
36	8488	607.200		37	8540	608.500		37	8592	609.800	
36	8489	607.225		37	8541	608.525		37	8593	609.825	
36	8490	607.250		37	8542	608.550		37	8594	609.850	
36	8491	607.275		37	8543	608.575		37	8595	609.875	
36	8492	607.300		37	8544	608.600		37	8596	609.900	
36	8493	607.325		37	8545	608.625		37	8597	609.925	
36	8494	607.350		37	8546	608.650		37	8598	609.950	
36	8495	607.375		37	8547	608.675		37	8599	609.975	
36	8496	607.400		37	8548	608.700		37	8600	610.000	Reserved
36	8497	607.425		37	8549	608.725		37	8601	610.025	
36	8498	607.450		37	8550	608.750		37	8602	610.050	
36	8499	607.475		37	8551	608.775		37	8603	610.075	
36	8500	607.500		37	8552	608.800		37	8604	610.100	
36	8501	607.525		37	8553	608.825		37	8605	610.125	
36	8502	607.550		37	8554	608.850		37	8606	610.150	
36	8503	607.575		37	8555	608.875		37	8607	610.175	
36	8504	607.600		37	8556	608.900		37	8608	610.200	
36	8505	607.625		37	8557	608.925		37	8609	610.225	
36	8506	607.650		37	8558	608.950		37	8610	610.250	
36	8507	607.675		37	8559	608.975		37	8611	610.275	
36	8508	607.700	Reserved	37	8560	609.000		37	8612	610.300	
36	8509	607.725		37	8561	609.025		37	8613	610.325	
36	8510	607.750		37	8562	609.050		37	8614	610.350	
36	8511	607.775		37	8563	609.075		37	8615	610.375	
36	8512	607.800		37	8564	609.100		37	8616	610.400	
36	8513	607.825		37	8565	609.125		37	8617	610.425	
36	8514	607.850		37	8566	609.150		37	8618	610.450	
36	8515	607.875		37	8567	609.175		37	8619	610.475	
36	8516	607.900		37	8568	609.200		37	8620	610.500	
36	8517	607.925		37	8569	609.225		37	8621	610.525	

37	8622	610.550		37	8674	611.850		37	8726	613.150	
37	8623	610.575		37	8675	611.875		37	8727	613.175	
37	8624	610.600		37	8676	611.900		37	8728	613.200	
37	8625	610.625		37	8677	611.925		37	8729	613.225	
37	8626	610.650		37	8678	611.950		37	8730	613.250	
37	8627	610.675		37	8679	611.975		37	8731	613.275	
37	8628	610.700		37	8680	612.000		37	8732	613.300	
37	8629	610.725		37	8681	612.025		37	8733	613.325	
37	8630	610.750		37	8682	612.050		37	8734	613.350	
37	8631	610.775		37	8683	612.075		37	8735	613.375	
37	8632	610.800		37	8684	612.100		37	8736	613.400	
37	8633	610.825		37	8685	612.125		37	8737	613.425	
37	8634	610.850		37	8686	612.150		37	8738	613.450	
37	8635	610.875		37	8687	612.175		37	8739	613.475	
37	8636	610.900		37	8688	612.200		37	8740	613.500	
37	8637	610.925		37	8689	612.225		37	8741	613.525	
37	8638	610.950		37	8690	612.250		37	8742	613.550	
37	8639	610.975		37	8691	612.275		37	8743	613.575	
37	8640	611.000		37	8692	612.300		37	8744	613.600	
37	8641	611.025		37	8693	612.325		37	8745	613.625	
37	8642	611.050		37	8694	612.350		37	8746	613.650	
37	8643	611.075		37	8695	612.375		37	8747	613.675	
37	8644	611.100		37	8696	612.400		37	8748	613.700	
37	8645	611.125		37	8697	612.425		37	8749	613.725	
37	8646	611.150		37	8698	612.450		37	8750	613.750	
37	8647	611.175		37	8699	612.475		37	8751	613.775	
37	8648	611.200		37	8700	612.500		37	8752	613.800	
37	8649	611.225		37	8701	612.525		37	8753	613.825	
37	8650	611.250		37	8702	612.550		37	8754	613.850	
37	8651	611.275		37	8703	612.575		37	8755	613.875	
37	8652	611.300		37	8704	612.600		37	8756	613.900	
37	8653	611.325		37	8705	612.625		37	8757	613.925	
37	8654	611.350		37	8706	612.650		37	8758	613.950	
37	8655	611.375		37	8707	612.675		37	8759	613.975	
37	8656	611.400		37	8708	612.700					
37	8657	611.425		37	8709	612.725					
37	8658	611.450		37	8710	612.750					
37	8659	611.475		37	8711	612.775					
37	8660	611.500		37	8712	612.800					
37	8661	611.525		37	8713	612.825					
37	8662	611.550		37	8714	612.850					
37	8663	611.575		37	8715	612.875					
37	8664	611.600		37	8716	612.900					
37	8665	611.625		37	8717	612.925					
37	8666	611.650		37	8718	612.950					
37	8667	611.675		37	8719	612.975					
37	8668	611.700		37	8720	613.000					
37	8669	611.725		37	8721	613.025					
37	8670	611.750		37	8722	613.050					
37	8671	611.775		37	8723	613.075					
37	8672	611.800		37	8724	613.100					
37	8673	611.825		37	8725	613.125					

B Appendix B – TV Channel Frequency Chart for U.S.

	Carrier frequency	Channel No.	Freq limits
			54
v	55.25	2	
a	59.75		60
v	61.25	3	
a	65.75		66
v	67.25	4	
a	71.75		72
			76
v	77.25	5	
a	81.75		82
v	83.25	6	
a	87.75		88
			174
v	175.25	7	
a	179.75		180
v	181.25	8	
a	185.75		186
v	187.25	9	
a	191.75		192
v	193.25	10	
a	197.75		198
v	199.25	11	
a	203.75		204
v	205.25	12	
a	209.75		210
v	211.25	13	
a	215.75		216
			470
v	471.25	14	
a	475.75		476
v	477.25	15	
a	481.75		482
v	483.25	16	
a	487.75		488
v	489.25	17	
a	493.75		494
v	495.25	18	
a	499.75		500
v	501.25	19	
a	505.75		506
v	507.25	20	
a	511.75		512
v	513.25	21	
a	517.75		518
v	519.25	22	
a	523.75		524
v	525.25	23	
a	529.75		530
v	531.25	24	
a	535.75		536
v	537.25	25	
a	541.75		542

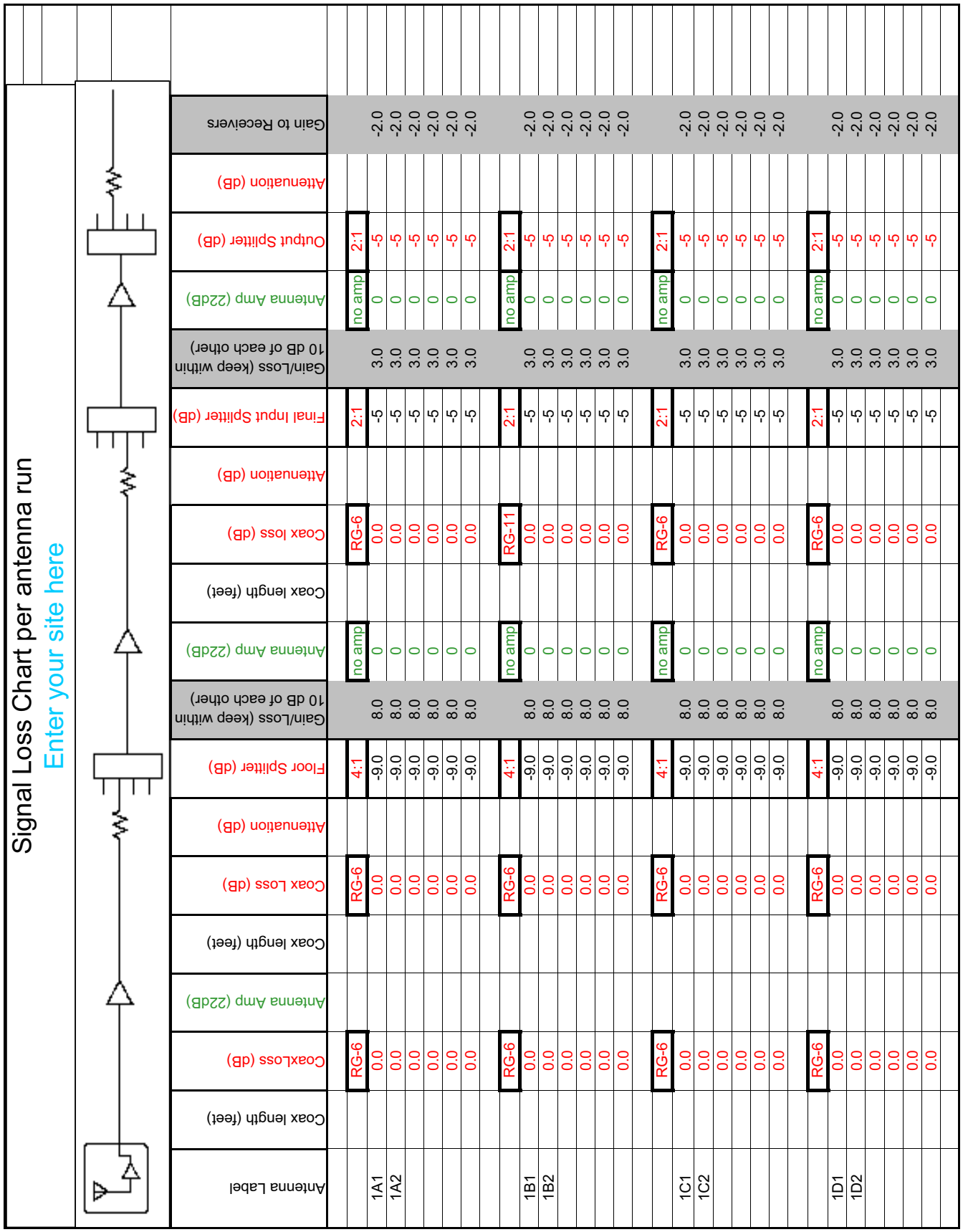
	Carrier frequency	Channel No.	Freq limits
			542
v	543.25	26	
a	547.75		548
v	549.25	27	
a	553.75		554
v	555.25	28	
a	559.75		560
v	561.25	29	
a	565.75		566
v	567.25	30	
a	571.75		572
v	573.25	31	
a	577.75		578
v	579.25	32	
a	583.75		584
v	585.25	33	
a	589.75		590
v	591.25	34	
a	595.75		596
v	597.25	35	
a	601.75		602
v	603.25	36	
a	607.75		608
v	609.25	37	
a	613.75		614
v	615.25	38	
a	619.75		620
v	621.25	39	
a	625.75		626
v	627.25	40	
a	631.75		632
v	633.25	41	
a	637.75		638
v	639.25	42	
a	643.75		644
v	645.25	43	
a	649.75		650
v	651.25	44	
a	655.75		656
v	657.25	45	
a	661.75		662
v	663.25	46	
a	667.75		668
v	669.25	47	
a	673.75		674
v	675.25	48	
a	679.75		680
v	681.25	49	
a	685.75		686
v	687.25	50	
a	691.75		692
v	693.25	51	
a	697.75		698
v	699.25	52	
a	703.75		704

	Carrier frequency	Channel No.	Freq limits
			704
v	705.25	53	
a	709.75		710
v	711.25	54	
a	715.75		716
v	717.25	55	
a	721.75		722
v	723.25	56	
a	727.75		728
v	729.25	57	
a	733.75		734
v	735.25	58	
a	739.75		740
v	741.25	59	
a	745.75		746
v	747.25	60	
a	751.75		752
v	753.25	61	
a	757.75		758
v	759.25	62	
a	763.75		764
v	765.25	63	
a	769.75		770
v	771.25	64	
a	775.75		776
v	777.25	65	
a	781.75		782
v	783.25	66	
a	787.75		788
v	789.25	67	
a	793.75		794
v	795.25	68	
a	799.75		800
v	801.25	69	
a	805.75		806
v	807.25	70	
a	811.75		812
v	813.25	71	
a	817.75		818
v	819.25	72	
a	823.75		824
v	825.25	73	
a	829.75		830
v	831.25	74	
a	835.75		836
v	837.25	75	
a	841.75		842
v	843.25	76	
a	847.75		848
v	849.25	77	
a	853.75		854
v	855.25	78	
a	859.75		860
v	861.25	79	
a	865.75		866

v = video a = audio All frequencies in MHz

C Appendix C – Signal Loss Chart

For your notes


Signal Loss Chart per antenna run
Enter your site here
Antenna Label
Coax length (feet)
CoaxLoss (dB)
Antenna Amp (22dB)
Coax length (feet)
Coax Loss (dB)
Attenuation (dB)
Floor Splitter (dB)
Gain/Loss (keep within 10 dB of each other)
Antenna Amp (22dB)
Coax length (feet)
Coax loss (dB)
Attenuation (dB)
Final Input Splitter (dB)
Gain/Loss (keep within 10 dB of each other)
Antenna Amp (22dB)
Output Splitter (dB)
Attenuation (dB)
Gain to Receivers
1A1
1A2
1B1
1B2
1C1
1C2
1D1
1D2
RG-6
RG-11
4:1
2:1
no amp
8.0
3.0
0.0
-9.0
-5
-2.0

D Appendix D – Radio Astronomy Sites for U.S.

Radio Astronomy Sites

Channel 37 is used for radio astronomy at the following locations:

Location	Latitude (North)	Longitude (West)
Kitt Peak, AZ	31ø-57'-23"	111ø-36'-45"
Owens Valley, CA	37ø-13'-54"	118ø-16'-34"
Mauna Kea, HI	19ø-48'-16"	155ø-27'-29"
North Liberty, IA	41ø-46'-17"	91ø-34'-27"
Hancock, NH	42ø-56'-01"	71ø-59'-12"
Los Alamos, NM	35ø-46'-31"	106ø-14'-44"
Pie Town, NM	34ø-18'-04"	108ø-07'-09"
*Socorro, NM	34ø-03'-43"	107ø-37'-04"
*Arecibo, PR	18ø-20'-46"	66ø-45'-11"
Fort Davis, TX	30ø-38'-06"	103ø-56'-41"
Saint Croix, VI	17ø-45'-31"	64ø-35'-03"
Brewster, WA	48ø-07'-52"	119ø-41'-00"
*Green Bank, WV	38ø-25'-59"	79ø-25'-59"

For a wireless medical telemetry device operating in channel 37 (608-614MHz) that will be located within 80 kilometers (48 miles) of the above radio astronomy observatory sites denoted with an asterisk, operation is not permitted until the frequency coordinator specified in 95.1113 has coordinated with, and obtained the written concurrence of, the director of the affected radio astronomy observatory before the equipment can be installed or operated.

For a wireless medical telemetry device operating in channel 37 (608-614MHz) that will be located within 32 kilometers (19.2 miles) of all remaining radio astronomy observatory sites (WITHOUT an asterisk) listed above, operation is not permitted until the frequency coordinator specified in 95.1113 has coordinated with, and obtained the written concurrence of, the director of the affected radio astronomy observatory before the equipment can be installed or operated.

The National Science Foundation point of contact for coordination is:

> Spectrum Manager, Division of Astronomical Sciences, NSF Rm. 1045, 4201 Wilson Blvd., Arlington, VA 22230, telephone: 703-306-1823.

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